# SECTION 13911--DRY PIPE FIRE PROTECTION SYSTEM

## PART 1--GENERAL

WORK INCLUDED: Work includes, but is not limited to:

Layout, fabricate, install, flush, and test fire protection systems including pipe, fittings, sprinkler heads, hangers, supports, earthquake bracing, expansion joints, and all necessary accessories and components to assure complete and operable dry pipe automatic sprinkler systems for the decontamination building.

RELATED SECTIONS:

01300 Submittals
09900 Painting
13120 Pre-Engineered Metal Building
13505 Underground Fire Water Distribution System

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

AMERICAN SOCIETY FOR TESTING MATERIALS (ASTM)

| | |
|---|---|
| ASTM A-53 | Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Weld and Seamless |
| ASTM A-795 | Stand Specification for Black, Hot-Dipped, Zinc Coated (Galvanized), Welded and Seamless Steel Pipe for Fire Protection Use |

INTERNATIONAL CONFERENCE OF BUILDING OFFICIALS (ICBO)

| | |
|---|---|
| UBC | Uniform Building Code |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 13 | Standard for the Installation of Sprinkler Systems |

FACTORY MUTUAL (FM)

| | |
|---|---|
| FM Approval Guide | Fire Protection |
| FM Data Sheet 2-8 | Earthquake Protection for Sprinkler Systems |
| FM Data Sheet 2-8N | Installation of Sprinkler Systems |

SYSTEM DESCRIPTION:

Reference Drawings: The reference drawings do not attempt to show complete details of the building construction which affect the fire protection installation. The drawings in part are diagrammatic and do not show all offsets, fittings, valves, equipment, etc. It is absolutely essential to study the architectural, structural, mechanical, and electrical drawings and confer with the various trades involved. To assure that there is no conflict between the fire protection system and the work of other trades and to assure that the owner secures the best arrangement of work consistent with the use of space.

Layout Requirements: This specification and the Regulatory Requirements outlined in Quality Control shall govern this layout.

The facility will consist of a treatment/decontamination building that will require a dry pipe sprinkler system for various associated occupancies as follows:

Treatment and decontamination areas along with mechanical equipment and equipment support areas shall have dry pipe automatic sprinklers installed throughout the areas. The sprinkler system shall be laid out to meet NFPA 13 and FM Data Sheet(s) 2-8 and 2-8N. The system shall be hydraulically designed to provide a minimum sprinkler density of 0.17 gpm/sq. ft over the most hydraulically remote 3500-sq. ft. or entire area, which ever is smaller. 500-gpm hose stream allowance shall also be provided in the hydraulic design. Sprinkler heads should be standard sprinkler uprights and shall be 212°F temperature rated.

Personnel area shall have dry pipe automatic sprinklers installed throughout the area using dry pendent sprinkler heads as detailed on the drawings. The sprinkler system shall be laid out to meet NFPA 13 and FM Data Sheet(s) 2-8 and 2-8N. The system shall be hydraulically designed to provide a minimum sprinkler density of 0.15 gpm/sq. ft over the most hydraulically remote 2500-sq. ft. or entire area, which ever is smaller. This area shall use 165°F temperature rated heads. An additional 500-gpm hose stream allowance shall be provided.

The water supply pressure and flow information available for use in the hydraulic calculations shall be obtained by a test taken as near possible to the two connections for the new underground fire loop as depicted on the drawings.

The maximum water velocity through the overhead sprinkler system shall not exceed 25 ft per second. The final hydraulic design requirements shall result in a water supply demand that is a minimum of 10% below the water supply curve.

Piping: All above ground piping used in this project for wet pipe systems shall conform to the Product section of this section. All exposed piping shall be labeled all other piping shall be labeled as a minimum. Piping leading from the fire department pumper connection to the first check valve, piping leading from the connection to the underground main, and all other piping, which is open to the atmosphere shall be galvanized piping.

Air Supply: The dry pipe valve and associated air maintenance device shall be arranged to avoid tripping due to water pressures of 165 psig. The air supply for this installation shall be obtained from a riser mounted tank air compressor. The air compressor shall be provided with an air dryer and filter assembly. The system shall be sized based upon a capacity capable of restoring normal air pressure in the system within 30 minutes. A by-pass around the air compressor shall be provided, to allow for the use of plant air, as a means of filling the system.

Obstructions: Sprinkler heads shall be installed under all obstructions to include ducts, lights, equipment, cable trays, racks of piping, or any combination of equipment per the requirements for obstructions.

Seismic Bracing: Earthquake sway bracing shall be provided based upon FM 2-8 using a "G" factor of 0.5. Calculations, using the zone of influence method, showing the forces on the attachments shall be done to verify that the minimum requirements outlined are not exceeding the allowable strengths of listed equipment or allowable strength of the building structure at the point of attachment. Details of the sway bracing shall be provided on the shop drawings and bracing calculation sheets.

The Subcontractor shall be responsible for coordinating with the building manufacture to assure the structure is capable of supporting both the static and dynamic loads imposed by the automatic sprinkler system layout. The forces developed at the point of connection to the structure must be taken into account and approved by the building structural designer.

Piping installed such that it is supported by laying directly on the building structural members or trapeze shall be secured in place to resist vertical moment as if it were hanging from the same members or trapeze. Exceptions will be allowed on a case by case basis with the concurrence of the Design Fire Protection Engineer.

Hangers: Layout shall be based upon pressures in excess of 100 psi. Hangers attaching to steel purlins shall be attached by connecting into the web of the purlin using side beam brackets. Hangers shall meet seismic requirements per FM 2-8.

Flushing Connections: Flushing connections shall be provided as required.

Sleeves and Penetrations: All pipes penetrating concrete or masonry walls or floors shall be sleeved. Sleeves shall be caulked to retain the proper fire wall rating and to prevent water entry from outside the building or between floors with an approved sealant. Sleeves shall extend 1 in. above the finished floor.

Sprinklers: Sprinklers heads shall be ½", upright or dry pendent, throughout the building. The office area and door vestibules shall use ½", dry pendent, ordinary temperature heads below the suspended ceiling and high temperature upright, heads above the suspended ceiling. Treatment and decontamination areas of the building shall use high temperature heads and equipment. Rooms shall use intermediate rated temperature heads.

Dry pendent sprinkler heads shall not be installed in any fittings or couplings that will allow moisture to accumulate above the seal of the sprinkler head.

Escutcheons: Two piece escutcheons shall be provided on all pendent sprinklers located beneath an intermediate ceiling.

Spare sprinkler heads shall be provided in accordance with NFPA 13 (a minimum of 6, 2 of each type). The spare heads shall be given to the Contractor's Representative.

Sprinkler Spacing: Sprinklers spacing shall be based upon the hazard protected, but in no case less required for Ordinary Hazard Group II.

Head Guards: Guards shall be placed around all heads which are subject to mechanical damage.

Control Valves: All valves controlling fire protection water supplies shall be provided with valve supervision capabilities.

Inspector Test Connections: Inspector test connections shall use a ¼ turn ball valve. Test connection valve shall be located at the hydraulically remote end of the system, approximately 6-ft. maximum above finished floor. It shall drain to the exterior of the building and shall be normally capped.

Low Point and Auxiliary Drains: Low point drains shall be arranged to allow system drainage without the use of ladder. The drains shall discharge to a safe location, preferably to the exterior of the building, if at all possible. Drain valves shall consist of 1/4-turn ball valves. Drains shall be normally capped.

Splash Blocks: The Subcontractor shall furnish splash blocks at the main drain, inspector's test connection, and all other exterior discharge locations that do not drain onto asphalt or concrete.

SUBMITTALS:

Layout Requirements: The fire suppression system layout shall be submitted as a complete bound package for review. A complete package shall consist of all working plans, hydraulic calculations, sway bracing calculations, and other vendor data required by this specification. Working plans shall contain all information required by NFPA 13, FM 2-8, 2-8N and include an outline showing all ductwork. Partial submittals will be considered as incomplete and will not be reviewed. The layout must be reviewed and receive an authorization to proceed by the Contractor prior to beginning of installation.

The Subcontractor shall submit all layout drawings for review and authorization to proceed prior to construction. All drawings shall be CAD generated and completed on size D (22 × 34 in.) drawings. Lettering size shall be a minimum of 1/8 (.125)" inch for all lettering on the main body of the drawing. Border and title block shall follow format in this drawing

package. An electronic copy in AutoCAD, DWG format, shall be furnished in addition to the original drawing plots. Electronic copies of border and title block format is available upon request. An A/E Drawing Standard format is available upon request.

As-built drawings in both hard copy and electronic shall be submitted. Additionally electronic and hard copy As-built hydraulic calculations, compatible with HASS 7.1 shall be submitted with the drawings.

Quality Control Submittals:

Procedures: The Subcontractor shall submit a hydrostatic test procedure and a detailed, job specific flushing procedure. The flushing procedure shall outline where the flushing water will be obtained and how it will be disposed of in a safe manner. It shall also outline how the flow will be monitored to assure adequate flow and how long the flow must be maintained to adequately flush the piping. This procedure must be submitted for review prior to any connections to existing plant piping.

Certifications: A Contractor's Material and Test Certification for Above-Ground Piping shall be completed and accepted, for each major portion of the work covered by this specification prior to final acceptance of the installation.

Test Reports: A final inspection form shall be submitted for the automatic sprinkler system installed or modified by this project. See Attachment 2 of this section for acceptance forms to be submitted.

Building Manufacture Letter: A letter from the steel building manufacture approving the method, location, and forces used in the attachment of earthquake sway bracing.

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

The sprinkler contractor for the fire sprinkler system shall have a NICET Certified Engineering Technician, (CET), in Fire Protection with a minimum Level IV rating, responsible for overseeing the preparation of the layout drawings and installation. This person shall be required to certify that the drawings are in accordance with this specification and all referenced regulatory requirements. All drawings shall be signed by the CET.

Manufacturers: Firms regularly engaged in the manufacture of fire sprinklers and piping accessories of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

Installer: A firm with at least 3 years of successful installation experience on projects with fire sprinkler piping similar to that required for this project. The installing Subcontractor shall be licensed by the State of Idaho as a Fire Protection Sprinkler Contractor.

UL Listed or FM Approved: Provide sprinkler piping, fittings, and devices with a UL listing and FM approval unless supplying the as specified product.

Exceptions will be made on a case by case bases for products submitted as Or Equals. If no product exists that has both a UL listing and FM Approval, it will be acceptable to use a product that has been published in either organizations publications.

Regulatory Requirements (Codes and Standards): Comply with the provisions of the following codes and standards unless otherwise specified herein.

NATIONAL FIRE PROTECTION ASSOCIATE (NFPA)

NFPA 13 "Standard for the Installation of Sprinkler Systems"

FACTORY MUTUAL (FM)

FM data sheet 2-8 "Earthquake Protection for Sprinkler Systems"
FM data sheet 2-8N "Installation of Sprinkler Systems"

Upon completion of the automatic sprinkler system installation, the individual with the NICET level IV or equivalent certification, shall conduct the final main drain test and verify the installation has been installed in accordance with the working drawings and meets the layout requirements of this specification.

DELIVERY, STORAGE AND HANDLING:

All materials shall be delivered to and stored at the job site in a manner which will prevent foreign material from getting inside the piping and valving.

SEQUENCING /SCHEDULING:

The static and dynamic loads associated with the fire protection system must be coordinated with the building structural design.

The underground fire water main must be flushed and accepted prior to connection to the sprinkler system riser.

DELIVERY, STORAGE AND HANDLING:

All materials shall be delivered to and stored at the job site in a manner which will prevent foreign material from getting inside the piping and valving.

SITE CONDITIONS:

This is new construction at the INEEL.

SEQUENCING/SCHEDULING:

The static and dynamic loads associated with the fire protection system must be coordinate with the building structural design.

PART 2--PRODUCTS

MATERIALS AND EQUIPMENT:

Sprinkler Piping: Galvanized steel piping shall be welded or seamless, Schedule 40, conforming to the requirements of ASTM A-53 or A-795. Schedule 10 UL listed or FM approved, or ASTM A-795 approved for 2-½ in. and larger pipe is acceptable in office areas. Welding will not be allowed on galvanized piping unless the weld effect area is hot dip galvanized after welding is completed.

Pipe Fittings:

Reduction in pipe size shall be made with one-piece reducing fittings. Bushings will not be acceptable. Plain-end fittings are not acceptable.

Welded fittings on galvanized piping will not be allowed unless the weld effected zone of the fitting and associated piping is hot dip galvanized.

Pipe Couplings:

Flexible couplings in pipelines shall be galvanized Victualic Style 75, 77, 750, HP-7. The grooving machine used to prepare the piping to except the flexible couplings shall be approved for use with the coupling by the coupling manufacture. Gaskets shall be flush seal.

Rigid couplings in pipelines shall be galvanized Victualic Style 005, 07. The grooving machine used to prepare the piping to except the flexible couplings shall be approved for use with the coupling by the coupling manufacture. Gaskets shall be flush seal.

Plain end and welded couplings shall not be allowed.

Sprinkler Heads: All heads shall be listed and approved for use in the occupancies described above.

Sprinklers shall be Victaulic V2703 or V2707.

Dry type heads shall be Viking Model 7740F (VK154).

Sprinkler Guards: Shall be of the type that can be installed after the sprinkler head is installed. Guards shall be Viking Model D-1 or dry sprinkler guard.

Spare Sprinkler Heads: The Subcontractor shall furnish spare sprinkler heads in accordance with NFPA 13.

Fire Department Connections: Shall be of the siamese type, 2½ x 2½ x 4 in. and shall have two 2½-in. female swivel connections with National Standard fire hose threads. The fire department connections shall be Potter-Roemer Model 5710. Two 2½ in. plugs shall be included and shall be Potter-Roemer Model 5950. An identification plate labeled "AUTOSPKR" shall be provided.

Control Valve:

Butterfly Valve: A butterfly valve with weather proof actuator housing, have a positive indication for the open and closed position, and be prewired for valve supervision. It shall be Victaulic Series 708-W, or series 727.

Outside Screw and Yoke (OS&Y): Valves shall be UL listed and FM approved. American Flow Control, Series 500.

Water Motor Alarm: The water motor alarm shall be Central Model F-1.

Dry Pipe Valve: The dry pipe valve shall use a positive latching mechanism and be complete with factory supplied trim, including a water motor alarm, water flow alarm switch, and low-pressure air switch. The valve shall be UL listed and FM approved. Victaulic Series 756, with proper trim.

Air Maintenance Device: This device shall reduce the pressure of the in coming air supply in order to maintain system air pressure. The air maintenance device shall be by the same manufacture as the dry pipe valve.

Air Compressor: The air compressor shall be a riser mounted system. Viking model E-1 Maintenance Air Compressor.

Air Dryer: Air dryers shall be the inline desiccant type designed to provide a dew point of at least -20° F. A coalescing type prefilter shall be provided with the air dryers.

Concrete Block Anchors:

Grout-filled: Anchors shall be a rated for ASTM C90, concrete block, filled with 2000 psi grout conforming to ASTM C474. Hilti model HIT HY 150 Injection Adhesive Anchor or HVA Adhesive System.

Hollow Block: Anchors shall be approved for use in ASTM C90, type II, hollow concrete block. Hilti model Sleeve Anchor.

Pipe Stands: Pipe stands shall be adjustable and have a pipe saddle. Tolco Fig. 319 with Fig. 317 saddle.

Check Valves:

Swing Check: Swing check valves shall have a removable faceplate to allow for maintenance of the valve without the need of removing it from the system. Viking model G-1.

Wafer Check: Wafer check valves shall contain an o-ring sealed clapper, torsion spring loaded, and be of the butterfly valve type. Grinnell, Model F512.

Water Flow Pressure Alarm Switch: Pressure type water flow alarm switch with built in recycling pneumatic retard and two sets of SPDT contacts shall be provided as part of the Alarm Valve trim. Potter-PS10-2 Pressure Type Flow Switch.

Hangers:

Threaded side beam brackets, TOLCO Fig. 58 with bolt and hex nut fastener.

C-Type beam clamps with retaining strap, TOLCO Fig. 65, 66. Retaining strap TOLCO Fig. 69.

Ring Hanger, TOLCO Fig. 2, 2NFPA, and 200.

Surge Restrainer: TOLCO Fig. 25.

Straps: Straps shall be UL Listed and FM approved, ¼" bolt holes, Carbon Steel. Grinnell Short Strap, Fig. 262.

Concrete Anchors: Anchors shall be Factory Mutual Approved for use in Pre-Cast Hollow Core, Post Tensioned, and Poured Concrete. Hilti Model HDI-P.

Earthquake and Sway Bracing: Bracing shall be UL listed or designed by a registered Professional Engineer in the State of Idaho. TOLCO.

Inspector Test Connections: Inspector test connections shall use a 1/4-turn ball valve. The test connection valve shall be located at the hydraulically remote end of the system, approximately 6 ft maximum above finished floor and drain to the exterior of the building.

Signs: All drain and test valves shall have identification signs per NFPA 13. Lettering shall be a minimum of ½ in. high white letters on red background.

Hydraulic Data Placards: Hydraulic data placards shall be metal and permanently embossed with the information required by NFPA 13. Subcontractor shall supply, fill in all the required information, and install the placards on the system riser.

Splash Block: Splash blocks shall be constructed of concrete.

Air Compressor: Air compressor shall meet the requirements of NFPA 13, 4-2.6.6.

Air Maintenance Device: Air maintenance device shall be UL listed or FM approved. Central Model DA.

Low Air Pressure Switch: Provide as a part of the dry pipe valve trim a low air pressure switch with two (2) sets of SPDT contacts. Pressure switch shall be Potter PS40-2.

PAINTING AND IDENTIFICATION OF PIPING

See Section 09900 Painting, for the requirements of painting and labeling all pipe, fittings, hangers, and devices. Galvanized piping need not be painted but shall be labeled.

PART 3--EXECUTION

Installation: Only new and approved sprinklers, piping, fittings, hangers, and devices shall be employed in the installation of the sprinkler system.

One set of approved fire protection layout drawings shall be maintained on the project site during construction. The Subcontractor shall redline all changes daily. The redline drawings shall be incorporated on the "as-built" layout drawings by the Subcontractor.

Stainless steel screwed fittings shall utilize TEFLON tape and/or TEFLON paste to prevent galling.

FIELD QUALITY CONTROL:

Acceptance Tests:

Flushing of Piping: New underground mains and lead-in connections to system risers shall be flushed thoroughly immediately after tie-in to system is made or before connection is made to the sprinkler piping.

Test of Dry Pipe System Piping: All new fire system piping shall be hydrostatically tested at not less than 225-psi pressure for two (2) hours with no visible leakage. All leaks shall be repaired and system retested.

Dry System Air Test: In addition to the standard hydrostatic test, an air pressure leakage test at 40 psi shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 1½ psi for the 24 hours shall be corrected.

Existing fire sprinkler systems requiring minor modifications and connections to existing systems shall be tested at the normal system working pressure for not less than twenty-four (24) hours and inspected with no visible leakage. Any leaks detected shall be repaired and re-tested.

Compressor Test: Verify the air compressor starts and stops at the correct air pressures for the dry pipe valve selected. Pressures must not exceed the maximum pressure or go below the minimum pressure as recommended by the dry pipe valve manufacture.

CLEANING:

Flushing of Piping: New underground mains and lead-in connections to system risers shall be flushed thoroughly immediately after tie-in to system is made or before connection is made to the sprinkler piping.

Sprinkler Pipe Flushing Procedure: Upon completion of installation, the system shall be filled and drained at least two (2) times. Water shall be run through the inspectors test connection or auxiliary drain until water flows clear.

Sprinkler Pipe Flushing Procedure: Upon completion of installation, the system shall be filled and drained at least two (2) times. Water shall be run through the inspectors test connection or auxiliary drain until water flows clear. Testing and flushing shall be witnessed by the Contractor's Representative. System shall be left in a drained condition.

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 13911

**Attachment 1**

Contractor's Material & Test Certificate

# CONTRACTOR'S MATERIAL AND TEST CERTIFICATE FOR ABOVEGROUND PIPING

**PROCEDURE**

**Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.**

**A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any daim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.**

| Property Name | Date |
|---|---|
| | |

**Property Address**

| | | |
|---|---|---|
| **PLANS** | Accepted by approving authorities (names) | |
| | Address | |
| | Installation conforms to accepted plans<br>Equipment used is approved.<br>If no, explain deviation | ☐ YES ☐ NO<br>☐ YES ☐ NO |
| **INSTRUCTIONS** | Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? If no, explain | ☐ YES ☐ NO |
| | Have copies of the following been left on the premises:<br>1. System Components Instructions<br>2. Care and Maintenance Instructions<br>3. NFPA 25 | ☐ YES ☐ NO<br>☐ YES ☐ NO<br>☐ YES ☐ NO |
| **LOCATION OF SYSTEM** | Supplies Buildings | |

| **SPRINKLERS** | Make | Model | Year of Manufacture | Orifice Size | Quantity | Temperature Rating |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |

| **PIPE AND FITTINGS** | |
|---|---|
| | Type of Pipe |
| | Type of Fittings |

| **ALARM VALVE OR FLOW INDICATOR** | Alarm Device | | | Maximum Time to Operate Through Test Connection | |
|---|---|---|---|---|---|
| | Type | Make | Model | Minutes | Seconds |
| | | | | | |
| | | | | | |

| **DRY PIPE OPERATING TEST** | Dry Valve | | | Q.O.D. | | |
|---|---|---|---|---|---|---|
| | Make | Model | Serial No. | Make | Model | Serial No. |
| | | | | | | |

| | Time to Trip Thru Test Connection* | | Water Pressure | Air Pressure | Trip Point Air Pressure | Time Water Reached Test Outlet* | | Alarm Operated Properly | |
|---|---|---|---|---|---|---|---|---|---|
| | Min | Sec | psi | psi | psi | Min | Sec | Yes | No |
| Without Q.O.D. | | | | | | | | | |
| With Q.O.D. | | | | | | | | | |

If no, explain

| **DELUGE & PREACTION VALVES** | | |
|---|---|---|
| Operation | ☐ Pneumatic ☐ Electric ☐ Hydraulic | |
| Piping Supervised ☐ YES ☐ NO | | Detecting media supervised ☐ YES ☐ NO |
| Does valve operate from the manual trip and/or remote control stations ☐ YES ☐ NO | | |

*Measured from thime inspector's test connection is opened.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DELUGE & PREACTION) VALVES (continued | Is there an accessible facility in each circuit for testing ☐ YES ☐ NO | | | | If no, explain | | | |
| | Make | Model | Does Each Circuit Operate Supervision Loss Alarm | | Does Each Circuit Operate Valve Release | | Maximum Time to Operate Release | |
| | | | Yes | No | Yes | No | Min | Sec |
| | | | | | | | | |
| PRESSURE REDUCING VALVE TEST | Location & Floor | Make & Model | Setting | Static Pressure | | Residual Pressure (Flowing) | | Flow Rate |
| | | | | Inlet (PSI) | Outlet (PSI) | Inlet (PSI) | Outlet (PSI) | Flow (GPM) |
| | | | | | | | | |
| TEST DESCRIPTION | Hydrostatic: Hydrostatic test shall be made at not less than 200 psi (13.6 bars) for two hours or 50 psi (3.4 bars) above static pressure in excess of 150 psi (10.2 bars) for two hours. Differential dry-pipe valve clappers shall be left open during test to prevent damage. All aboveground piping leakage shall be stopped. | | | | | | | |
| | Pneumatic: Establish 40 psi (2.7 bars) air pressure and measure drop which shall not exceed 1-1/2 psi (0.1 bars) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop which shall not exceed 1-½ psi (0.1 bars) in 24 hours. | | | | | | | |
| TESTS | All piping hydrostatically tested at ___ psi for ___ hrs.<br>Dry piping pneumatically tested ☐ YES ☐ NO<br>Equipment operates properly ☐ YES ☐ NO | | | | If no, state reason | | | |
| | Do you certify as the Sprinkler Contractor that additives and corrosive chemicals, sodium silicate or derivatives of sodium silicate, brine, or other corrosive chemicals were not used for testing systems or stopping leaks? ☐ YES ☐ NO | | | | | | | |
| | Drain Test | Reading of gage located near water supply test connection: ___ psi | | | Residual pressure with valve in test connection open wide ___ psi. | | | |
| | Underground mains and lead in connections to system risers flushed before connection made to sprinkler piping.<br>Verified by copy of the U Form No. 85B ☐ YES ☐ NO Other Explain<br>Flushed by installer of underground sprinkler piping ☐ YES ☐ NO | | | | | | | |
| | If powder driven fasteners are used in concrete, ☐ YES ☐ NO has representative sample testing been satisfactorily completed | | | | | | If no, explain | |
| BLANK TESTING GASKETS | Number Used | | | Locations | | | Number Removed | |
| WELDING | Welded Piping ☐ YES ☐ NO<br>If Yes... | | | | | | | |
| | Do you certify as the Sprinkler Contractor that welding procedures comply with the requirements of at least AWS D10.9, Level AR-3 | | | | | | ☐ YES | ☐ NO |
| | Do you certify that the welding as performed by welders qualified in compliance with the requirements of at least AWS D10.9, Level AR-3 | | | | | | ☐ YES | ☐ NO |
| | Do you certify that welding was carried out in compliance with a documented quality control procedure to ensure that all discs are retrieved, that openings in piping are smooth, that slag and other welding residue are removed, and that the internal diameters of piping are not penetrated | | | | | | ☐ YES | ☐ NO |
| CUTOUTS (DISCS) | Do you certify that you have a control feature to ensure that all cutouts (discs) are retrieved? ☐ YES ☐ NO | | | | | | | |
| HYDRAULIC DATA NAMEPLATE | Name Plate Provided ☐ YES ☐ NO | | | | If no, explain | | | |
| REMARKS | Date left in service with all control valves open: | | | | | | | |
| SIGNATURES | Name of Sprinkler contractor | | | | | | | |
| | Tests Witnessed By | | | | | | | |
| | For Property Owner (Signed) | | Title | | | Date | | |
| | For Sprinkler Contractor (Signed) | | Title | | | Date | | |

**Additional Explanation and Notes**

**Attachment 2**

# FINAL INSPECTION FORM

| INEEL FIRE PROTECTION INSTALLATION<br>FINAL INSPECTION FORM | |
|---|---|
| Sprinkler Contractor name and address | _____<br>_____<br>_____ |
| Facility Inspected Building/System No./ Control Valve No. | _____<br>_____<br>_____ |
| Inspection by:<br>Name<br>address<br><br>phone | _____<br>_____<br>_____<br>_____<br>_____<br>PE or CET No _____ |

I have personally inspected the automatic sprinkler system referenced above and found it to be installed in accordance with the approved working drawings and associated review comments. The attached As-Built drawings and hydraulic calculations reflect the installation as it presently exists.

The following is the results of the main drain test conducted during my inspection:

Static Pressure: _____ Psig
Residual Pressure: _____ Psig

I certify that all areas of the building covered by the above referenced system have been protected in accordance with NFPA, Factory Mutual, and the project specifications, and all signs and placards have been installed.

_____ Date: _____
(Signed by PE or CET)

Comments or Exceptions: _____
_____
_____
_____
_____
_____
_____
_____

# SECTION 15401--PLUMBING SYSTEMS

## PART 1--GENERAL

### SUMMARY:

Section Includes But Is Not Limited To: Furnish and install plumbing systems including hot and cold potable water, sanitary sewer systems, and raw water systems as detailed herein and as shown on the subcontract drawings. Systems shall include all piping, fittings, fixtures, and appurtenances associated with the work described herein.

Related Sections: The following Sections of this Specification contain work closely related to the work of this Section.

Division 2, Section: Underground Water Systems
Division 2, Section: Underground Sanitary Sewer Main and Branch Systems
Division 2, Section: Earthwork

### SYSTEM DESCRIPTION:

Underground Potable Water (U-Drawings): Underground potable water systems from the potable water supply main up to the building stub-up are covered under Division 2 Sections of this Specification.

Underground Raw Water (U-Drawings): Underground raw water systems from the raw water supply main up to the building stub-up are covered under Division 2 Sections of this Specification.

Potable Water – Cold (P-Drawings): Cold potable water systems covered under this section begin with the stub-up of the underground branch line and continues throughout the building to the various plumbing fixtures supplied with cold potable water, including all piping, fittings, valves, hangers, and appurtenances as detailed herein and as shown on the subcontract drawings.

Potable Water – Hot (P-Drawings): Hot potable water begins at the water heater supplied under this section and continues throughout the building to the various plumbing fixtures supplied with hot potable water, including all piping, fittings, valves, hangers, and appurtenances as detailed herein and as shown on the subcontract drawings.

Raw Water (P-Drawings): Raw water systems covered under this section begin with the stub-up of the underground branch line and continues throughout the building to the various fixtures supplied with raw water, including all piping, fittings, valves, hangers, and appurtenances as detailed herein and as shown on the subcontract drawings.

Sanitary Sewer (P-Drawings): Sanitary sewer systems covered under this section begin at the plumbing fixture and continue to the building foundation line, including all piping,

fittings, valves, and appurtenances as detailed herein and as shown on the subcontract drawings.

Underground Sanitary Sewer Main and Branch Systems (U-Drawings): Underground sanitary sewer main and branch systems from the building foundation line to the sanitary sewer main are covered under Division 2 Sections of this Specification.

Plumbing Fixtures (P-Drawings): Plumbing fixtures covered in this section include all fixtures that are supplied with hot or cold potable water, raw water, or which are connected to the sanitary sewer system.

SUBMITTALS:

Submittals for this section shall be bound together in a single package, and shall be labeled with the project title, "Plumbing Systems Submittals," and the subcontractor's name. The submittal package shall include all of the following information:

Product Data: Product data shall be submitted for all valves and plumbing fixtures supplied under this section.

Test Reports: Test procedures and reports shall be submitted for each test required by this section.

Operation and Maintenance Manuals: O&M Manuals for water heaters and back flow prevention devices shall be submitted.

Warranty: Warranty information for water heaters, back flow prevention devices, and system installation shall be submitted.

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements:

QUALITY CONTROL:

Qualifications: Firms regularly engaged in the fabrication and installation of plumbing systems in accordance with the regulatory requirements, codes, and standards listed below, and similar in scope to the requirements of this project.

Regulatory Requirements, Codes, and Standards: Comply with the provisions of the following codes and standards unless otherwise specified herein.

INTERNATIONAL ASSOCIATION OF PLUMBING
AND MECHANICAL OFFICIALS (IAPMO)

Uniform Plumbing Code (UPC)

Uniform Mechanical Code (UMC)

DELIVERY, STORAGE AND HANDLING:

All items supplied under this section shall be delivered in an undamaged condition. Once on site, all items shall be protected from weather, and shall be handled in a manner that will not cause damage to the items. Factory packaging and coverings shall remain on all items supplied with packaging or coverings as long as practical for protection prior to installation.

PROJECT CONDITIONS:

Field Measurements: All dimensions shown on the subcontract drawings are for bidding purposes only, and shall be field verified. Excessive discrepancies in drawing dimensions and field measurements shall be brought to the attention of the Contractor's Construction Engineer.

SEQUENCING/SCHEDULING:

The Plumbing Systems subcontractor shall coordinate installation of plumbing systems with the work of other trades. In particular, excavation, concrete placement, and finish work should be carefully coordinated with the work of this section.

PART 2--PRODUCTS

POTABLE AND RAW WATER PIPING:

Pipe: Pipe shall be seamless copper water tubing, hard or soft drawn, Type L or Type K, straight length or coil, in accordance with ASTM B88.

Fittings: Fittings for copper tubing shall be wrought copper or bronze solder type pressure fittings in accordance with ANSI B16.22

Valves: Valves for copper tubing shall be ball-type, two piece, sweat ends, reduced port, pressure rated at 600 psi WOG, 150 psi saturated steam, in accordance with Federal Specification WW-V-35C, Type II, Class A, Style 3. Valves shall be Watts Series B-6001.

Solder and Flux Materials: All solder and fluxes shall be manufactured to approved standards for potable water systems. Solders and fluxes with a lead content which exceeds two-tenths of one (1) percent (0.2 %) are prohibited.

SANITARY SEWER AND VENT PIPING:

Building Sanitary Sewer and Vent Piping: Piping shall be acrylonitrile-butaliene-styrene (ABS), schedule 40, plastic drain, waste, and vent piping and fittings in accordance with ASTM D2661-94a.

ABS Joining Materials and Methods: Solvent cement shall be for ABS DWV plastic pipe and fittings in accordance with ASTM D2235-93a.

PLUMBING FIXTURES:

Cleanouts: Cleanouts shall be to match the floor or wall area where installed. Floor cleanouts shall be of the adjustable type. Floor cleanouts shall be Zurn Model ZN-1400-HD. Finished wall area cleanouts shall be Zurn Model ZN-1441. Exposed line cleanouts shall be Zurn Model Z-1440.

Drinking Fountain: Drinking Fountain (DF) shall be self-contained, wall hung electric refrigerated water cooler, capable of delivering a minimum of 8.0 GPH of 50 degree F drinking water based on 80 degree F inlet water temperature. Fountain shall be Elkay Model EBFATL8C.

Fixture Supply Lines and Isolation Valves: Fixture supply lines shall be sized in accordance with fixture manufacturer's instructions, chrome-plated copper with isolation valve stops.

Floor Drains: Floor drains shall match the floor area where installed. Floor drains shall be Zurn ZN-400 Series, with applicable outlet and options to match the installation conditions.

Lavatories: Lavatories shall be wall mount with hangar, Kohler Model K-2032-0, complete with K-7404-K faucet, K-16010-5 handles, drains, and traps.

Utility Sink: Utility sinks shall be stainless steel single-compartment, Dayton Model DE-11515, complete with mixing faucet, and drain trap.

Floor (Mop) Sinks: Floor sinks shall be stainless steel floor service sinks for janitorial functions of flushing and rinsing floor mops and waste pails. Sinks shall be Elkay Model EFS-2523-C, complete with Elkay LK-401 rigid spout mixing faucet with integral non-removable vacuum breaker, and Elkay LK-403 3-station wall mount mop hanger.

Water Closets: Water closets shall be wall mount, Kohler Model K-4330-0 complete with supports, K-4670-C open front seat, and Sloan Model 111 flush valve, and other required accessories for a complete installation.

Urinals: Urinals shall be wall mount, Kohler Model K-4960-ET-0 complete with supports and Sloan Model 186-1 flush valve, and other required accessories for a complete installation.

Water Hammer Arrestor: Water hammer arrestors shall be Smith Model 5020.

Water Heater: Water heater shall be A. O. Smith Model DEN-120, 208-V, 4500 watt elements, non-simultaneous operation, complete with relief valve, thermostat, and other required accessories for a complete installation.

Showers: Shower stalls shall be fiberglass with gelcoat, Aqua Glass Model 313637AC, Kohler Model K-T6910-4A shower trim, K-304-K mixing valve, and other required accessories for a complete installation.

Potable Water Backflow Preventer: Backflow preventer shall be Watts Regulator Model 709-QT double check valve backflow preventer assembly.

Raw Water Backflow Preventer: Backflow preventer assembly shall be Watts Model 909-PR, by BAVCO at 1-800-458-3492.

Raw Water Hose Reels: Hose reels shall be Hannay Reels Model 3016-24-26 with 100 feet of 3/4" water hose.

## PART 3--EXECUTION

### GENERAL INSTALLATION OF ALL SYSTEMS:

Shall be in conformity with the applicable requirements of the Uniform Plumbing Code.

Pipelines shall be installed per the drawings. The Subcontractor shall coordinate the work of all trades involved on this project to prevent interferences. Piping shall not be routed so as to block equipment access panels or to prevent routine maintenance activities. Piping shall be routed around all electrical components to maintain proper National Electrical Code clearances. The Subcontractor shall notify the Contractor of potential interference issues prior to routing piping.

Items such as valves, controls, access doors, specialties, and accessories shall be installed so as to be readily accessible for operation, servicing, maintaining and repairing.

Install pipe to uniform pitches between points for which elevations are established. Use level or other approved method to accomplish this. Provide bends or elbows for changes in directions. One-quarter bends shall be long sweep type.

Between bends or elbows, lines shall be straight, free from irregularities, and have smooth interior surfaces.

Anchorage against slippage shall be provided by means of concrete or masonry piers, tie rods and pipe clamps, or other approved means. Joints shall be made accessible for inspection and repair prior to testing.

Unions or flanges shall be used to install valves and equipment so as to facilitate dismantling as may be required.

Increasers or decreasers will be required for changes in the size of pipes and fittings. Bushings shall not be used.

Anchors and guides shall be provided as required.

Piping shall be concealed in finished rooms and wherever shown on the drawings. Exposed piping shall be run close to other piping, walls and columns. Runs shall be as close together as possible where under ceilings, slabs, and decks. Rack piping on trapeze hangers where possible.

PIPE SLEEVES:

Install standard weight pipe for pipes passing through job cast concrete and masonry walls.

Diameters of sleeves shall not be larger than required for unrestricted expansion and contraction.

Length of sleeves shall be such that when installed, they will project 2 in. above floors, and be flush with finished surfaces of walls and ceilings.

PIPE JOINTS AND CONNECTIONS:

All Pipe Joints: All pipe joints shall be in accordance with Section 316 of the Uniform Plumbing Code.

PIPE IDENTIFICATION AND VALVE TAGS:

All nonburied pipelines shall be color-coded and identified using full English text names according to following list. Identification shall be at approximately 20-ft intervals with at least one identifier in each room. Any pipes entering or leaving a room shall be identified on each side of the wall.

PIPE CONTENT IDENTIFICATION LIST

| PIPE CONTENT AND LABEL TEXT | COLOR* |
|---|---|
| VENT, SANITARY | Yellow/Black |
| VENT, UTILITY | Blue/White |
| WASTE, SANITARY | Yellow/Black |
| WATER, POTABLE COLD | Green/White |
| WATER, POTABLE HOT | Green/White |
| WATER, RAW | Green/White |

* Background Color / Letter Color

Size of Labels

| Outside Diameter of Pipe of Covering (in.) | Width of Color Band A (in.) | Size of Legend Letters B (in.) |
|---|---|---|
| 3/4 to 1 1/4 | 8 | 1/2 |
| 1 1/2 to 2 | 8 | 3/4 |

(All dimensions are given in inches.)

EQUIPMENT, FIXTURES, ETC.:

Fixtures shall be installed and supported per the applicable drawings in a safe, rigid, neat, and orderly manner. They shall be free from undue stresses and made suitable for normal use. Wall mounted supports shall be of the type as recommended by the manufacturer of the fixture used.

All of the above shall be protected from damage during and after installation. At completion, work shall be free from tool marks, discoloration, cracks, scratches, chips and other defects.

HANGERS, SUPPORTS AND FASTENERS:

Pipe hangers shall be fabricated and installed as shown on the subcontract drawings. Where interferences occur with hanger placement, the Subcontractor shall submit an alternative position to the Contractor for approval.

Where hangers are not shown on the Subcontract drawings, the Subcontractor shall install hangers and supports in accordance with the Uniform Plumbing Code.

PIPE SLEEVES:

Install standard weight pipe for pipes passing through job cast concrete and masonry walls.

Diameters of sleeves shall not be larger than required for unrestricted expansion and contraction.

Length of sleeves shall be such that when installed, they will project 2 in. above floors, and be flush with finished surfaces of walls and ceilings.

Seal annulus space between pipe and sleeve in accordance with U.L. requirements wherever piping passes through firewalls.

FIELD QUALITY CONTROL:

Testing: Hot and cold potable water systems and raw water systems shall be tested in accordance with the Uniform Plumbing Code Section 609. Sanitary waste piping systems shall be tested in accordance with the Uniform Plumbing Code, Section 723.

Contractor Inspections: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

CLEANING AND DISINFECTION:

Precautions shall be taken to maintain cleanliness of materials and equipment during delivery, storage and installation. Piping, valves, fittings, and equipment shall be visually free from grease, cutting oils, loose particles, ships, or other foreign matter.

All piping systems shall be flushed or purged with water for 10-min minimum.

All potable water piping systems shall be disinfected in accordance with Section 15480.

END OF SECTION 15401

# SECTION 15480--STERILIZATION OF WATER PIPING

## PART 1--GENERAL

### WORK DESCRIPTION:

The Subcontractor shall furnish all services and supplies and perform all work and operations necessary for the sterilization of all water piping systems as specified herein.

WORK INCLUDED: Work includes, but is not limited to:

Sterilization of all underground and above ground potable water and raw water pipe, fittings, fixtures, and tie-in points.

### QUALITY CONTROL:

Codes and Standards: Comply with the requirements of the current revision of the following codes and standards, and as specified in this specification.

AMERICAN WATER WORKS ASSOCIATION (AWWA)

| | |
|---|---|
| AWWA C651 | Standard Specification for Disinfection of Water Mains |

### SUBMITTALS:

Submit test reports indicating satisfactory sterilization of all piping sterilized under this section.

## PART 2--PRODUCTS

### GENERAL:

Not Applicable.

## PART 3--EXECUTION

### CLEANING AND TESTING:

All piping systems and tie-in points shall be cleaned and tested in accordance with Section 15401 of this specification prior to sterilization.

Sterilization:

General: The potable water and raw water piping systems and tie-in points shall be sterilized with a clean water and chlorine solution in accordance with AWWA C651. The Subcontractor shall make the necessary arrangements for disposal of the water when draining the system. All cleaning and sterilizing shall be done in the presence of the Contractor's Representative.

Procedure: The isolating block valves in the existing main shall be closed and the new system shall be drained, thoroughly flushed with water and then drained again.

Gradually open upstream block valve and fill system with clean water while introducing the chlorine solution.

Samples shall be taken at the farthest point (test point) in the system from the point of chlorine injection. The concentration at the test point shall measure a minimum of 50-ppm residual chlorine. Water containing the prescribed chlorine concentration shall remain in the system for a period of at least 8 hours.

The system shall then be thoroughly drained, flushed and refilled with clean water, as often as necessary, until the chlorine content of the water at the test point is decreased to 20 ppm residual or less. Drain all chlorinated water to the service waste drain system.

Sampling: Samples of water taken from the sterilized lines of the system shall be delivered by the Subcontractor to the Industrial Hygiene Section Building INTEC 602, for analysis prior to use of water system. Sterilized sample bottles can be obtained at INTEC 602.

Sterilized samples bottles shall not be opened prior to actual sampling time. Every precaution shall be taken to minimize the possibility of contaminating the sample bottles.

Water samples shall be taken from sample points farthest from the water source and as directed by the Contractor. The sample point shall be fully opened and the water allowed to run to waste for a minimum of three minutes. The flow shall then be restricted to permit filling sample bags without splashing. All samples shall be accompanied with a complete and accurate identifying data sheet. The Subcontractor shall deliver the water samples to the Industrial Hygiene Section at INTEC 602 within the same working shift.

If the sample analysis indicates contamination is present, or that the residual chlorine content is greater than 2.0 ppm, the Subcontractor will sterilize and reflush the entire system and have samples tested as often as necessary, until the specified test results are obtained. The locations used for sampling in each area, shall be rotated on a routing basis with emphasis placed on points farthest away from the water supply.

It should be noted that the sampling is for total coliform bacteria and no coliforms should be found.

All pipe, valves and fittings which cannot be sterilized in accordance with the procedure outlined above shall be thoroughly scrubbed in a disinfecting solution containing 1,000 ppm hypochlorite solution (1 lb. of HTH to 75 gallons of water), allowed to stand for 30 minutes and flushed with clean water before installation.

FIELD QUALITY CONTROL:

Surveillance will be performed by Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 15480

# SECTION 15800--HEATING AND COOLING SYSTEM

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall furnish and install all equipment, material, supplies and perform all work and operations necessary for installation of the Heating System with related equipment as specified herein.

Section Includes: Work includes, but is not limited to:

Furnish and install wall mounted and ceiling hung electric radiant unit heaters.

Furnish and install wall mounted electric resistance unit heaters.

Test the complete installation including controls to verify proper function and operation as specified herein.

Coordinate the installation of the heating system with the air-distribution system of this specification and other trades.

### REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | National Electrical Code |
| NFPA 90B | Standard for the Installation of Warm Air Heating and Air Conditioning Systems |

### SYSTEM DESCRIPTION:

Electric radiant heaters provide heating to the conditioned spaces for all areas of the facility except the inlet air ceiling plenum. The inlet air plenum is heated with electric resistance unit heaters. Air is drawn from the inlet air ceiling plenum into the PPE/Change Room, Radcon Room, Locker Rooms, and hallway, and exhausted through exhaust fans. Heating systems are thermostatically controlled as described on the HV-drawings.

SUBMITTALS:

Submittals for this section shall be bound together in a single package, and shall be labeled with the project title, "Heating System," and the subcontractor's name. The submittal package shall include all of the following information:

Heaters: Product data, operation and maintenance manuals, electrical diagrams, and warranty shall be submitted for each heater type supplied under this section.

Commissioning Reports: Indicate results of startup and testing commissioning requirements. Submit copies of checklists.

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements:

QUALITY CONTROL:

Installer: Firms with successful installation experience on projects with heating systems similar to those required for this project.

Comply with ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers) rating and installation recommendations, except as otherwise indicated.

Comply with NFPA 90B

Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

Comply with NFPA 70 - National Electrical Code.

Manufacturers: Firms regularly engaged in manufacture of heating and cooling systems of types and sizes required and whose products have been in satisfactory use in similar service. Equipment shall be as specified.

DELIVERY, STORAGE, AND HANDLING:

Deliver: Deliver heating system and other equipment furnished in this section in factory wrapped containers. Coordinate delivery of units in sufficient time to allow movement into/onto structure.

Store: Store heating system and other equipment furnished in this section in clean dry space; protect from dirt, fumes, water, and construction traffic.

Handle: Handle equipment furnished in this section carefully to avoid damage to components and finish. Protect finish during installation. Do not install damaged equipment; replace damaged parts or equipment and remove them from project site. Handle units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

WARRANTY:

General Warranty: The special warranty specified in this Article shall not deprive the Contractor of other rights the Contractor may have under other provisions of the Subcontract Documents and shall be in addition to, and run concurrent with, other warranties made by the Subcontractor under requirements of the Subcontract Documents.

Special Warranty: A written warranty, executed by the manufacturer and signed by the Subcontractor, agreeing to replace components that fail in material or workmanship, within the specified warranty period, provided the manufacture's written instructions for installation, operation, and maintenance have been followed.

Warranty Period: Manufacturers standard, but not less than 5 years after date of Substantial Completion.

PART 2--PRODUCTS

EQUIPMENT:

Heaters: Heaters shall be supplied and installed as shown on the subcontract drawings. Heater make and model numbers are depicted on the Heating and Ventilation Equipment Schedule of the HV-drawings.

PART 3--EXECUTION

INSTALLATION/APPLICATION/ERECTION:

Setting: All equipment shall be installed in conformance with the manufacturer's recommendations and set in proper alignment. Each item shall be leveled and adjusted for proper height by means of leveling bolts, plates, and/or shims. Equipment supports

shall be independent of associated piping, component brackets, and supports or other similar attachments.

Protective Coatings: After completion of the installations and before testing or initial operation of the equipment all special protective temporary coatings, covers, etc., which were applied for protection during shipment and storage, and which did not require removal for assembly and/or installation shall be removed.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: The Subcontractor shall operate each heater and document that each heater works as designed and detailed on the subcontract drawings.

Subcontractor Inspection: The work shall be inspected and tested by the Subcontractor to verify compliance with the Subcontract drawings and specifications.

Contractor Surveillance: Surveillance will be performed by the Contractor to verify compliance of the work to the Subcontract drawings and specifications.

END OF SECTION 15800

# SECTION 15801--AIR DISTRIBUTION SYSTEM

## PART 1--GENERAL

### SUMMARY:

This section includes, but is not limited to air distribution systems including all ductwork, fans, and accessories as shown on the subcontract drawings and specified herein. The subcontractor shall furnish and install all equipment, materials, and supplies, and perform all work and operations necessary for the construction of the air distribution system as shown on the subcontract drawings and specified herein. Upon completing installation, the Subcontractor shall operate and test the system as specified hereinafter to verify that the system is properly installed and operates as required.

Section Includes: Work includes, but is not limited to:

### SYSTEM DESCRIPTION:

Air distribution system includes exhaust ductwork, ceiling grilles, dampers, louvers, filters (excluding HEPA filters and housings), and exhaust fans.

Design Requirements: System components shall be designed to operate at the given design parameters at an altitude of 5,000 ft.

### SUBMITTALS:

Submittals for this section shall be bound together in a single package, and shall be labeled with the project title, "Ventilation System," and the subcontractor's name. The submittal package shall include all of the following information:

Exhaust Fans: Product data, operation and maintenance manuals, electrical diagrams, and warranty shall be submitted for each exhaust fan type supplied under this section.

Commissioning Reports: Indicate results of startup TAB and testing commissioning requirements. Submit copies of checklists.

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements:

### QUALITY CONTROL:

The Subcontractor shall comply with the requirements of the current revision of the following codes and standards, as referenced and specified in this section.

AIR MOVEMENT AND CONTROL ASSOCIATION (AMCA)

| | |
|---|---|
| AMCA 500 | Louver Testing Requirements |

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

| | |
|---|---|
| ASTM A36 | Standard Specification for Structural Steel |
| ASTM A240 | Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels |
| ASTM A526 | Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality |
| ASTM A527 | Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality |
| ASTM C518 | Standard Test Method for Steady-State Heat Flux Measurements and thermal Transmission Properties by Means of the Heat Flow Meter Apparatus |
| ASTM C534 | Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form |
| ASTM C795 | Standard Specification for Wicking-Type Thermal Insulation for Use Over Austenitic Stainless Steel |
| ASTM D1056 | Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber |
| ASTM E96 | Standard Test Methods for Water Vapor Transmission of Materials |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 90A | Standard for the Installation of Air Conditioning and Ventilating Systems |
| NFPA 90B | Standard for the Installation of Warm Air Heating and Air Conditioning Systems |

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION, INC. (SMACNA)

| | |
|---|---|
| SMACNA | HVAC Duct Construction Standards |
| SMACNA | HVAC Systems - Duct Design |
| SMACNA | Rectangular Industrial Duct Construction Standards |
| SMACNA | Round Industrial Duct Construction Standards |

UNDERWRITERS LABORATORIES (UL)

UL-181 Factory-Made Air Ducts and Air Connectors

UNIFORM MECHANICAL CODE (UMC)

PART 2--PRODUCTS

GENERAL:

All materials, products, and equipment shall be manufactured as specified in this section. Products shall be in accordance with SMACNA Duct Construction Standards (HVAC, Round, or Rectangular) and the Uniform Mechanical Code.

Ductwork size, location, and permissible fitting configurations are shown on the subcontract drawings. All fittings installed in the ductwork system shall have loss coefficients less than or equal to those shown in the SMACNA "HVAC Systems Duct Design" Loss Coefficient Tables.

DUCTWORK:

All duct material shall be in accordance with this specification and the appropriate SMACNA Duct Construction Standard. Decon Bay and Treatment Area ductwork shall be in accordance with Round Industrial Duct Construction Standards, with pressure classifications of negative (-)10 inches water gage. Other ductwork shall be in accordance with HVAC Duct Construction Standards. Unless otherwise shown on the subcontract drawings, material gage, duct reinforcing, and connections shall be in accordance with the applicable SMACNA Standard. The abrasive particulate classification for the duct system is Class 1. Specific weight of particulate to be conveyed in the duct system is 0-lb./cubic ft.

Duct system material substitutions shall be approved by the contractor's representative. In the case of a substitution, the subcontractor shall provide calculations proving that noise level, total pressure loss, system flow characteristics, and integrity for an "or equal" substitution are all equal to or better than the system as designed and specified.

GS Duct Materials: Duct materials for GS designated systems shall be galvanized sheet metal in accordance with ASTM A526 or ASTM A527.

SST Duct Materials: Duct material for SST designated systems shall be 304L stainless steel in accordance with ASTM A240.

DUCTWORK HANGERS AND SUPPORTS:

Unless otherwise shown on the subcontract drawings, ducts shall be supported with materials in accordance with SMACNA "HVAC Duct Construction Standards" for GS designated ductwork, and Round or Rectangular "Industrial Duct Construction Standards" for CS and SST designated ductwork. Hangers and supports for flexible ducts shall be in accordance with the duct manufacturer's recommendations and SMACNA "Industrial Duct Construction Standards."

DUCT SYSTEM EQUIPMENT:

Equipment shall be as scheduled on the Heating and Ventilation Equipment Schedule of the subcontract drawings.

Flex Connections (for GS ductwork): To prevent vibration transmission and absorb expansion, flexible connections shall be installed immediately upstream of each exhaust fan in accordance with SMACNA "HVAC Duct Construction Standards" Figure 2-19. Flexible connections shall be 30-oz. neoprene impregnated nylon fabric duct material.

Flex Connections (for SST ductwork): Where shown on the subcontract drawings to prevent vibration transmission and absorb expansion, flexible connections shall be installed upstream of each exhaust fan. Flex connection shall be rated for the pressure classification of the duct system. Flexible element shall be 1/8-in. neoprene/polyester material rated for up to 250°F. Connection shall be capable of allowing 1-in. axial compression, 1/2-in. axial extension, and 3/4-in. lateral offset. Flex connection shall be Flow-Flex Series 1000 Expansion Joint (carbon steel for CS designated ductwork, stainless steel for SST designated ductwork).

Flex Duct: Flex duct may be utilized for connection to ceiling registers and grilles. The subcontractor shall supply and install flexible duct for connection from hard duct systems to equipment. Construction of flexible duct shall be in accordance with SMACNA "HVAC Duct Construction Standards." Flexible duct shall conform to NFPA Standard 90A and 90B and be tested in accordance with Underwriters Laboratory's Standard for Factory made Duct Materials, UL-181 Class 1, and must be installed in accordance with the conditions of their listing by UL. Duct shall be Atco Rubber Products Flexible Air Duct System.

Cleanouts: Cleanouts shall be provided where shown on the Subcontract drawings in accordance with ASHRAE standards.

Ductwork Sealant: Duct sealant shall be nonhardening, nonmigrating mastic or liquid elastic sealant as compounded and recommended by the manufacturer specifically for sealing joints and seams in ductwork.

DUCTWORK INSULATION:

Insulation shall be installed where shown on the subcontract drawings. No asbestos will be allowed. All insulation shall meet NFPA Standards for low fire hazard classification of: Flame Spread - 25 maximum, Fuel Contributed - 50 maximum, and Smoke Developed - 50 maximum.

Elastomeric Duct Insulation: Elastomeric duct insulation 2 inches thick shall be in accordance with ASTM C534. Operating temperature limits shall be minus 40°F to plus 220°F. Thermal conductivity shall be no greater than 0.27 (Btu in.)/(hr sq. ft deg F) at 75°F mean temperature, in accordance with ASTM C518. Moisture absorption shall be no more than 6% by weight in accordance with ASTM D1056. Insulation shall be resistant to Ozone. Insulation shall have a water vapor permeability of 0.17 perms in accordance with ASTM E96. Insulation shall be Armstrong Armaflex II. For outdoor applications, insulation shall be covered with a weather resistant protective finish of the same manufacturer as the insulation. Finish shall be Armstrong WB Armaflex Finish for Armaflex II insulation.

PART 3--EXECUTION

FABRICATION AND INSTALLATION OF DUCTWORK:

Assemble and install ductwork in accordance with recognized industry practices which will achieve air tight and noiseless systems capable of performing each indicated service. Install each run with a minimum of joints. Align ductwork accurately at connections. Coordinate duct installation with installation of accessories, coil frames, equipment, controls, and other associated work of the ductwork system. Installation shall be in accordance with SMACNA Duct Construction Standards (HVAC, Round, or Rectangular) and the Uniform Mechanical Code.

All ductwork welding shall be in accordance with Section 15016 of this specification.

Ductwork shall be arranged and spaced to clear structural framing and the work of other trades. Piping or other interferences shall not pass through ducts.

Access panels shall be installed at each fire damper, and elsewhere as shown on the subcontract drawings. Access panels shall be in accordance with SMACNA "HVAC Duct Construction Standards."

Ductwork connections shall be in accordance with the applicable SMACNA Duct Construction Standard (HVAC for GS designated systems, Round Industrial or Rectangular Industrial for CS and SST designated systems). Ductwork connections for CS and SST designated duct systems shall be butt welded except at equipment connections or where flanges are shown on the subcontract drawings or where ductwork

connects to equipment. All equipment connections shall be flanged. Gasket material for flanged connections shall be 1/8-in. neoprene.

Duct Sealing: All ductwork shall be sealed in accordance with SMACNA "HVAC Duct Construction Standards" Section S1.8 and S1.9.

Duct Gage, Supporting, and Reinforcing: Unless otherwise shown on the subcontract drawings, duct gage, hangar spacing, and reinforcing shall be as follows: GS designated ductwork shall be in accordance with SMACNA "HVAC Duct Construction Standards" Section IV. CS or SST designated ductwork shall be in accordance with "SMACNA Round Industrial Duct Construction Standards" or "Rectangular Industrial Duct Construction Standards." Flexible ductwork shall be in accordance with the manufacturer's recommendations and SMACNA "HVAC Duct Construction Standards" Sections S3.35 through S3.40. The abrasive particulate classification for welded duct systems is Class 1. Specific weight of particulate to be conveyed in welded duct systems is 0-lb./cubic ft. Hangars shall be installed in accordance with the requirements of the appropriate SMACNA standard for the duct material gage, reinforcing, pressure classification, and duct classification. In addition, hangars shall be installed where shown on the subcontract drawings. Hangars and supports shall not be installed to precast concrete, metal decks, steel bracing or bridging, conduit, or piping. The Subcontractor shall submit as-built drawings of the ductwork system showing duct gage, reinforcing type, and hangar location including type and upper and lower connection type for all ductwork installed by this project.

Equipment Installation: Equipment installation shall be in accordance with SMACNA "HVAC Duct Construction Standards" and the manufacturer's recommendations. Holes for damper rods, thermostats, etc. shall be drilled or machine punched.

CLEANING AND PROTECTION:

Clean Ductwork Internally: Clean ductwork internally, unit-by-unit as it is installed. Clean external surfaces of foreign substances which might cause corrosive deterioration of the metal. Or, where air distribution accessories and ductwork are to be painted, clean surfaces of foreign substances which might interfere with painting or cause paint deterioration.

Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent the entrance of dust and debris until the time connections are to be completed.

FIELD QUALITY CONTROL:

Contractor Supplied Testing: No testing will be performed by the Contractor.

Subcontractor Supplied Testing: The subcontractor shall arrange for testing, adjusting, and balancing of the entire air distribution system with all equipment installed. Balancing shall be by a Firm licensed by the NEEB and licensed Professional Engineers in the State of Idaho. Submit TAB Report upon final completion of test. Air flows shall be within +10% and -0% of values shown on drawings.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 15801

# SECTION 15883--HEPA FILTER HOUSINGS

## PART 1--GENERAL

### SUMMARY:

This specification covers the design, fabrication, inspection, testing, cleaning, and shipment of two HEPA filter housings. Each housing shall be a bag-out, side access fluid seal unit, configured as shown on the subcontract drawings.

Work includes, but is not limited to:

Test, furnish and install HEPA filter housings meeting the requirements in these specifications and to the configurations shown on the subcontract drawings.

Install Government furnished HEPA filters and prefilters.

Furnish and install differential pressure gage, switch and instrument tubing.

### QUALITY CONTROL:

Design: HEPA filter housing design shall conform to ANSI N509 and ERDA 76-21, Nuclear Air Cleaning Handbook.

Inspection: All equipment furnished in accordance with this specification will be subject to inspection by the Contractor's Representative during any phase of fabrication or testing.

### SUBMITTALS:

See the Vendor Data Schedule.

### DELIVERY, STORAGE, AND HANDLING:

All components shall be packaged to prevent damage and the entry of dirt or moisture during shipping and outdoor storage for a six-month period.

## PART 2--PRODUCTS

### HEPA FILTER HOUSINGS:

Filter housings shall be fabricated of 14 gage, type 304, 304L, 316 or 316L stainless steel, for an internal pressure of 10 in. w.g. and UBC Seismic Zone 3. The design shall meet ANSI N509 and ERDA 76-21.

The housing shall be a side-servicing bank type arrangement that does not require the air to change direction through the housing or as it enters or exits the housing. All joints and seams shall be welded airtight and ground smooth. The unit shall be free of all burrs and sharp edges. All mechanical components and filter slide plates shall be 300 series stainless steel.

Filter housings with multiple filters shall have removal rods to draw the filters to the bag-out position. Filter housings shall have locking arms in each tier to operate the mechanism, which engages and disengages the filters on the internal mounting frame. This mechanism shall be such that it will transmit a positive force on both the top and bottom edge of each filter to prevent tipping or binding of the filters as they are pulled into or away from the knife edge seal. Both the removal rod and the locking arm shall be operated through the polyvinyl bag identified in Section 2.2.3.8.

The filter housings shall have a removable access door and bag-out port for each tier of filters and a separate access door for prefilters. There shall be four tie down latches per access door and they shall be spring loaded in such a manner that they pivot away from the bag-out port after release, so that they do not impede the bag-out process. The filter locking arm and access door shall interface in such a manner that the door cannot be closed until the filters are correctly seated in the housing and sealed to the mounting frame.

Doors shall be fitted with closed cell neoprene gaskets in accordance with ASTM-D1056, Grade SCE-43. The gasket shall be mounted to the door (as opposed to the housing) and shall be manually replaceable (after door has been removed).

On the upstream side of each filter position there shall be a smooth inlet design that provides a minimum 3/4 in. depth recess around the upstream perimeter of the filter to limit the buildup of contaminants in crevasses or fillets that would have been caused by the junction of the filter's integral frame and the housing wall. All flanges of the housing that connect to the system shall turn to the outside.

The filter-to-frame seal in each filter housing shall be effected by means of a continuous knife edge on the mounting frame that mates to a continuous perimeter channel on the face of the filter which has been filled with a viscous, non-drying fluid. The knife edge seal frame shall be square to within $\pm$1/16 in.

The filter housing shall be designed to fit fluid seal HEPA filters (24 x 24 x 11_ in.), which are Government furnished.

Each filter housing access door shall have a bag-out port inside the door that has been hemmed on its outer edge to prevent tearing of the bag. There shall be two continuous ribs on the outside of the port to hold the bag's elastic shock cord and the safety strap during the bag-out operation.

One PVC bag shall be furnished for each access door on each filter housing. It shall be 0.008 in. thick, amber in color with a transparent, smooth textured finish, and shall have an elastic shock cord hemmed into the mouth of the bag for a firm fit when stretched around the bag-out port. A stock number shall be provided with the bag.

A nylon safety strap shall be provided with each bag-out port to prevent the bag from slipping off during the bag-out procedure. The strap shall have a neoprene laminate on one side to prevent slippage. A cinching strap shall also be provided with each bag-out port to tie off the slack in the bag while the ventilation system is operating.

Each door shall be equipped with an exterior metal pocket for the filter housing instruction manual which shall be provided at the same time the housing is delivered and shall contain complete, detailed and separate instructions on filter arrangement including installation, operation, maintenance, and spare parts. The manual shall be contained in weatherproof bags.

For DOP test sections, all filter testing shall be able to be conducted from a location outside of the system using apparatus and devices which are supplied as an integral part of the test sections including mixing devices and sample ports. The upstream and downstream test chambers shall contain identical mixing devices to mix and disperse a uniform challenge air/aerosol ahead of each filter, and sample the effluent upstream and downstream of the filter being tested. Challenge aerosol inlet ports and upstream and downstream sample ports shall be provided for each HEPA filter. The pressure drop across each test section shall be no greater than 0.25 in. w.g. (at 1000 cfm per filter) during the test. All mixing devices shall be designed to swing aside when testing has been completed.

The in place testing design shall be proof tested in a multiple filter. It shall be shown that the leaking filters can escape detection in the conventional ten duct diameter test wherein the entire bank is challenged, but that they can be "found" by the individual efficiency test. The proof test shall include four test arrangements using various plenum and transition pieces for a comparison of efficiency readings under different conditions. All efficiency readings shall be accompanied by upstream sample readings taken at a minimum of fifteen points ahead of each filter on three planes. The combined assembly including filter housing and test sections shall be the product of a single manufacturer.

DOP test section challenge aerosol inlets shall be 1 in. IPS, Schedule 40, Type 304 stainless steel. Sample ports shall be _ in. IPS, Schedule 40 Type 304 stainless steel. These connections shall be provided with Type 304 stainless steel pipe caps.

The filter housing shall be provided with flanges for connecting to the ductwork transitions pieces. Furnish the required gaskets.

Static pressure ports shall be located on top of the housing upstream and downstream of the prefilters and filters. Connections shall be 1/4-in. pipe nipple with cap.

Instrument Tubing: Tubing shall be stainless steel Type TP304 per ASTM A269. Fittings shall be compression type and shall be Swagelok.

Differential Pressure Gauge: The gauge shall be diaphragm actuated, shall have 3-7/8 in. diameter white dial with black figures and graduations, shall have pointer zero adjustment and shall be furnished complete with two static pressure tips, fittings for 1/4 in. metal tubing and means for mounting the gauge. Gauge shall be Magnahelic No. 2003-AF reading to 0-3 in. water, in 0.10-in. divisions as manufactured by Dwyer Instruments, Inc.

Differential Pressure Switch: Differential pressure switches shall be diaphragm operated to actuate two single pole double throw snap switch. Motion of the diaphragm shall be restrained by a calibrated spring that can be adjusted to set the exact pressure differential at which the electrical switch will be actuated. Motion of the diaphragm shall be transmitted to the switch button by means of a direct mechanical linkage operating range of the switches shall be 0.5 to 6.0 in. of water. Switches shall be Dwyer Instruments, Inc., Catalog No. 1627-5.

## PART 3--EXECUTION

### INSTALLATION:

Installation of Equipment: All equipment shall be installed in conformance with the manufacturer's recommendations, this specification and the drawings. Each unit shall be leveled and adjusted for proper height by means of leveling bolts, plates and/or shims. Equipment supports shall be independent of associated piping and ductwork, component brackets and supports or other similar attachments.

Filters (GFE): The high efficiency HEPA filters for installation in the filter housings will be furnished by the Government but shall be installed by the Subcontractor in accordance with the subcontract drawings and these specifications.

### QUALITY CONTROL TESTING:

Subcontractor Supplied Testing:

General: A housing leak test and an in-place DOP test are required.

Test programs and procedures shall be submitted for the housing leak test and filter fit test specifying test to be performed, the acceptance criteria, and time schedule of testing. Tests shall be made only by persons who have demonstrated their competence to satisfactorily make the specific test and certified in accordance with ANSI N510-1980, N509, and ERDA 76-21.

Housing Leak Test: The test is used to verify the leak integrity of the filter housing assembly. The presence of leaks is disclosed by a pressure decay test to be conducted prior to shipment from the factory. In this test the housing shall be blanked off at the inlet and the outlet and shall be tested by the pressure decay method in accordance with ANSI N510-1980 to 10-in. w.g. as specified in Table 4-4. Following this test, each filter position shall be fitted with an airtight filter-shaped plug and the housing knife edge shall be tested by the pressure decay message in accordance with ANSI N509-1980 to 10 in. w.g. as specified in ANSI N509-1980, Table 4-4.

If the presence of leaks is shown, the leaks are then located by the bubble method and repaired after which the housing is retested by the pressure decay method. A leak indication is any bubble 1/16-in. (0.06 in.) diameter that forms in 1 second, or a bubble 9/32-in. (0.28-in.) that forms in 1 min. Tests shall be performed in accordance with ANSI/ASME N510, Paragraph 6.

Test reports shall be submitted for approval following testing. Failed tests and necessary repairs shall also be reported and identified as to location.

Filter Fit Test: After fabrication, each of the filter housings shall be tested for filter fit. HEPA filters, of type Flanders Model No. T-007-0-02-05 NU Size GG-F (dimensions of 24 x 24 x 11-1/2 in.) shall be placed in each of the filter housings. After the filter elements are in place, visual inspection shall confirm that the elements fit without binding and that the seal is completed.

In-Place DOP Test: The in-place DOP test shall be performed by others after the filters are installed. Penetration shall be limited to the 0.03 percent and, if exceeded, the filters must be resealed and retested until an efficiency of 99.97 has been achieved. The Subcontractor shall furnish all labor and materials required should resealing of the filters be required.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 15883

# SECTION 16000--ELECTRICAL GENERAL PROVISIONS

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall provide, install, terminate, and test all the systems as described in the specification and shown on the drawings to make complete and operational electrical systems.

Work includes, but is not limited to:

Power distribution including 12.5 kV feed, transformers, feeders, panels, and safety switches.

Fire Alarm System (FAS), Emergency Communications (ECS), Telephone (TELE), and data systems.

Power system grounding, data, and communication systems grounding.

Lighting, exterior and interior.

Head bold heater rack installation.

Related Sections:

| | |
|---|---|
| 02200 | Earthwork (duct bank installation) |
| 03300 | Cast-In-Place Concrete |
| 15506 | On-Off Multicycle Preaction Fire Suppression System (Life Safety System) |

### REFERENCES:

The following documents, including others referenced therein, form part of this section to the extent designated herein. Unless otherwise indicated, use the latest edition in effect as of the date of these specifications.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI C-2 | National Electrical Safety Code (NESC) |

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA-70 | National Electrical Code (NEC) |
| NFPA-101 | Life Safety Code |

CODE OF FEDERAL REGULATIONS (CFR)

29 CFR 1910 Subpart S OSHA Electrical Safety

FACTORY MUTUAL

NATIONAL RECOGNIZED TESTING LABORATORIES (NRTL)

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

INTERNATIONAL ELECTRICAL TESTING ASSOCIATION (NETA)

CANADIAN STANDARDS ASSOCIATION (CSA)

UNDERWRITERS' LABORATORIES, INC. (UL)

UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors

SUBMITTALS:

See Section 01300, Submittals, other electrical sections and the Vendor Data Schedule for submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with the following codes and standards, except as modified herein:

Underwriters Laboratories (UL): All materials, appliances, equipment or devices shall conform to the applicable standards of Underwriters Laboratories, Inc. All material, appliances, equipment or devices shall be listed and/or labeled by UL or other nationally recognized testing laboratories such as the CSA.

Completed electrical system shall conform with applicable provisions of the Special Conditions, the Technical Specification, and the subcontract drawings.

PART 2--PRODUCTS

GENERAL:

Furnish all labor, materials, equipment and appliances required to complete the installation of the complete electrical systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Code (NEC), the National Electrical Safety Code (NESC), Occupational Safety and Health Administration (OSHA), and the terms and conditions of the electrical utility. All modifications required by these

codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor.

MANUFACTURERS:

Where multiple units of a product are required for the electrical work, provide identical products by the same manufacturer without variations except for sizes and similar variations as indicated.

MATERIALS:

Except as otherwise indicated, furnish new electrical products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of the product, or required by governing regulations.

Unless otherwise indicated by the drawings or specifications or approved in writing, the materials and/or equipment furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment, and shall be the manufacturer's standard design.

Environmental Conditions:

Climatic and Geographic Site Conditions

| | |
|---|---|
| Site Elevation | 4,917 feet |
| Barometric Pressure | 12.27 psia |
| Relative Humidity | 90% max. at 30 degrees F dry bulb |
| | 15% min. at 60 degrees F dry bulb |
| Uniform Building Code | Seismic Zone 2B |
| Temperature | +104 degrees F max. |
| | -40 degrees F min. |

NEMA 3R enclosures shall be provided for all outdoor equipment and equipment located in the decontamination bay and treatment area of the Decontamination Facility. NEMA 1 enclosures shall be provided for all other indoor equipment unless noted otherwise on drawings.

Labeling: Install permanent labels on all electrical panels, cabinets, disconnects, motor starters, major equipment or components, receptacles, and switches. See Section 16195 - Electrical Identification for labeling requirements.

PART 3--EXECUTION

SEQUENCING/SCHEDULING:

General: It is recognized that the subcontract documents are diagrammatic in showing certain physical relationships which must be established within the electrical work and in its interface with other work, including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Subcontractor.

Arrange electrical work in a neat, well organized manner with conduit and similar services running parallel with the primary lines of the building construction, and with a minimum of 7 ft-0 in. overhead clearance.

Locate operating and control equipment properly to provide easy access, and working clearance in accordance with the NEC.

Advise other trades of openings or clearances required in their work for the subsequent move-in and assembly of large units of electrical equipment.

Electrical connections shall be tightened to torque specifications stated by the equipment manufacturer. If manufacturer has no recommended torque value, tighten as per UL 486A.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: Upon completing installation of all systems and equipment, but prior to project close out, the Subcontractor shall conduct an operational test of all equipment, controls and devices installed or modified by the Subcontractor. All equipment shall test satisfactory or be repaired or replaced at no additional cost to the Contractor.

The Subcontractor shall test all devices in the presence of the Contractor's Representative. Subcontractor shall coordinate testing with the Contractor and schedule testing a minimum of 2 weeks in advance of the test. The Subcontractor shall inform the Contractor in writing of the scheduled test to allow the Contractor to designate the Contractor's Representative. This operational testing is in addition to testing required in separate sections of this specification.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16000

# SECTION 16109--SWITCHES, RECEPTACLES AND WALL PLATES

## PART 1--GENERAL

### SUMMARY:

Subcontractor shall provide and install switches and receptacles of sizes, ratings, materials and types as shown on the drawings.

Section Includes: but is not limited to:

Installation of new devices as detailed on the drawings.

Related Sections:

16000 Electrical General Provisions

### REFERENCES:

See the list of general references in Section 16000.

### SUBMITTALS:

Submittals include, but are not limited to the following:

1. Receptacle test procedure.
2. Receptacle test results.

See Section 01300, Submittals, other electrical sections for additional submittal requirements.

Submit adequate data to show that "or equal" materials, equipment or components are equal to specified materials, equipment and components.

## PART 2--PRODUCTS

### MATERIALS:

Switches: Provide specification grade toggle switches, grounding type with green equipment ground screw, 20 ampere, 120 VAC, with mounting yoke insulated from mechanism, equipped with plaster ears, switch handle, and side-wired screw terminals. Switches shall be single-pole or 3 way as indicated by the drawing symbols as shown on the drawings. Where more than one switch is shown at an outlet, switches shall be installed under a gang plate in an order appropriate to outlet location.
Switch color shall be Ivory.

Acceptable manufacturers and models include the following:

| | |
|---|---|
| Hubble | Model 1121 (single-pole) |
| Hubble | Model 1123 (3 way) |
| Leviton | Model CS120-2 (single-pole) |
| Leviton | Model CS320-2 (3 way) |
| Pass & Seymour | Model 20AC1 (single-pole) |
| Pass & Seymour | Model 20AC3 (3 way) |

Occupancy Sensors:

Occupancy sensors shall be a wall switch type with a manual adjustment that allows the time delay to be set from 3 to 30 minutes. This adjustment shall be concealed behind the front cover. The sensor shall utilize passive infrared technology to determine occupancy. The coverage pattern shall be 32 ft. wide and 40 ft. long. The unit and wall plate shall be ivory. Hubbell WS1277I.

Receptacles:

General-Duty Duplex: Provide specification grade, flush or surface mounted receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 20 ampere, 125 V, with metal plaster ears, side wiring, NEMA Configuration 5-20R unless otherwise indicated on the drawings. Acceptable manufacturers and models include the following:

| | |
|---|---|
| Hubble | Model 5342 |
| Daniel Woodhead | Model 5352DW |
| Pass & Seymour | Model 5342 |

Ground Fault Circuit Interrupter (GFCI) Receptacle: Provide commercial grade, duplex general duty ground fault circuit interrupter receptacles, 2-pole 3-wire grounding, feed-through type, flush or surface mounted, capable of protecting connected downstream receptacles on single circuit, grounding type, UL rated Class A, Group 1, 20 ampere rating, 125 V, 60 Hz; equipped with 20 ampere plug configuration NEMA 5-20R. Acceptable manufacturers and models include the following:

| | |
|---|---|
| Hubble | Model 5352A |
| Daniel Woodhead | Model 5352GF |
| Pass & Seymour | Model 2091 |

Wall Plates: Provide single switch and duplex outlet wall plates for wiring devices, with ganging and cutouts as indicated, provide with metal screws for securing plates to devices, screw heads finished to match plate finish, and with plates possessing the following additional construction features:

Material and Finish/Indoor Use: Cover plates shall be unbreakable nylon, ivory in color.

Material and Finish/Outdoor Use: Receptacle covers installed outdoors shall be rain tight with a NEMA 3R rating. They shall maintain this rating even when equipment is plugged in. This shall be accomplished by using flip lids or similar. Cover shall close automatically when released. All components of receptacle cover shall be made of corrosion resistant materials.

Power Cords: Provide power cords for the head bolt heaters as shown on the drawings. Cords with a 20-ampere rating shall consist of a 3 conductor, #12 AWG with a neoprene jacket, 600 V, Belden 19206 with a 20-ampere watertight connector body Hubbell HBL15W33. Cords with a 30 ampere rating shall consist of a 3 conductor #10 AWG with a neoprene jacket, 600 V, Belden, 19205 with a 30 ampere, 2 pole 3 wire twist-lock watertight connector body Hubbell HBL2613SW.

Cable Reels: Cable reels shall be of the weatherproof type. They shall be equipped with 50 feet of 12/3 SOW-A cable, rated for 600 volts and 20 amperes. The assembly shall have a NEMA type 4X rating and shall be furnished with a 20-ampere, straight blade, watertight connector body. Hubbell HBL201232W with a Hubbell HBL15W33 connector.

## PART 3--EXECUTION

### INSTALLATION:

Install receptacles, switches and wall plates where indicated on the drawings in accordance with recognized industry installation practices.

Receptacles to be mounted 18 in. from floor unless shown otherwise on the drawings. Switches to be mounted 48 in. from floor unless shown otherwise on the drawings.

Coordinate with other work including electrical raceway and equipment installation work, as necessary to interface installation of wiring and devices with other work.

Install receptacles and switches only in electrical boxes which are clean and free from building materials and debris.

### LABELING:

Label all covers and plates. Install labels per Section 16195--Electrical Identification.

FIELD QUALITY CONTROL:

Subcontractor Supplied Inspection and Tests: The Subcontractor or his agents shall perform the following:

1. Visual inspection to determine that equipment installation conforms to NEC, these specifications and the drawings.
2. Subsequent to hooking-up cables/wires and devices, energize circuitry and demonstrate functioning in accordance with requirements.
3. Each receptacle shall be tested with a portable receptacle circuit tester to test for polarity, grounds, and opens.

Subcontractor shall furnish a data sheet, listing room numbers or area and number of receptacle tested and test results.

Circuit tester shall be Daniel Woodhead No. 1750 for standard circuits. GFI receptacles shall be tested with Daniel Woodhead Model No. 1753.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16109

# SECTION 16110--ELECTRICAL RACEWAYS

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall provide and install electrical raceways for power, communications and data systems.

Section Includes, but is not limited to:

1. Provide and install electrical raceways of types, grades, and sizes specified on the drawings.
2. Provide complete assembly of raceway including, but not necessarily limited to, couplings, elbows, adapters, hold-down straps, and other components and accessories as needed for a complete system.
3. Coordinate as necessary to integrate installation of electrical raceways and components with other work.
4. Label all conduits.
5. Provide and install all manholes, handholes and accessories.

Related Sections:

02200 Earthwork
03300 Cast-In-Place Concrete
16000 Electrical Sections

### REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. See the list of general electrical references in Section 16000.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B1.20.1 Pipe Threads, General Purpose (Inch)

METAL FRAMING MANUFACTURER ASSOCIATION (MFMA)

MFMA-1 Metal Framing Channel

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| RN-1 | Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit |
| VE-1 | Metallic Cable Tray Systems |

SUBMITTALS:

Submittals include, but are not limited to the following:

Vendor data is NOT required for this section unless an "or equal" item is submitted for review.

PART 2--PRODUCTS

MATERIALS:

Conduit:

Metal Conduit: Rigid metal (RGS) conduit or Intermediate Metal Conduit (IMC) shall be used for all conductors buried in earth, in masonry, in concrete, and in damp or wet locations. All conduit shall be UL approved, ¾-in. minimum unless shown otherwise on the drawings.

PVC Conduit: Polyvinyl chloride (PVC) conduit shall be heavy wall, Schedule 40, rated 90°C. PVC may be used for telephone, fire alarm, feeders underground, and branch circuits installed under floor slabs. All underground bends of 30° or more shall be rigid galvanized steel conduit.

EMT: Electrical Metallic Tubing (EMT) shall be installed in interior locations as indicated on the drawings. EMT shall be UL approved, standard weight, electro-galvanized steel, ¾-in. minimum size.

Multi-Cell Raceway: The multi-cell raceway system shall consist of 4-1.19" ID PVC inner ducts surrounded with a 4" PVC, Type "C" outer shell. All multi-cell raceways and fittings shall be of the same manufacturer. Carlon, Multi-Guard Multi-Cell Raceway.

Liquid-tight, flexible conduit shall be installed in wet locations. Liquid-tight flex shall be grounding-type with a PVC jacket.

Fittings: Conduit fittings for rigid conduit (RGS or IMC) shall be rust-resistant cast steel. Conduit fittings for EMT shall be steel, rain-tight compression type.

Junction Boxes: All junction boxes shall be galvanized unless shown otherwise. Small junction boxes (4-11/16 in. square and smaller) shall be stamped from one piece of sheet

steel or welded construction and shall be galvanized. Where required to be weatherproof, small junction boxes shall be die-cast aluminum rated for wet locations. Enclosures larger than 12" x 12" shall be supported at each corner.

Framing Channel for Conduit/Box Support: Where indicated on the drawings or as required by the NEC, bolted framing channel shall be used to support conduits and electrical boxes. Galvanized steel channel shall be used in all outdoor/exterior locations and epoxy painted channel in all interior locations. The minimum size bolt used for bolting framing channel together for a support structure shall be 3/8". The exposed ends of all framing channel shall have a protective cap installed. Sizes shall be as detailed on the drawings. All framing channels shall be made of channel, fittings, and hardware as defined in MFMA-1 and shall be minimum 14-gauge steel.

Duct Supports: Rigid PVC spacers selected to provide minimum duct spacing and concrete cover depths indicated, while supporting ducts during concrete placement.

Manholes: Manholes shall be as shown on the drawings. For each manhole, furnish 1 stanchion for each 30 linear inches of interior floor perimeter. In addition, furnish 1 arm for each stanchion, 3 insulators for each arm, and a total of 3 pulling eyes. Furnish materials complete with associated fasteners, packaged with protective covering for storage and with identification labels clearly describing contents.
For manholes, use 36-in. cover except as indicated.

The manhole and its cover shall be designed for all applicable loads. The minimum live load shall be an AASHTO H-20 truck loading (32,000-lb. axle). The minimum snow load shall be 30 psf.

Accessories:

Manhole Frames and Covers: Thirty-six inch diameter minimum, cast iron with words "Electrical", "Communications" or "Telephone" cast into the lid.

Pulling Eyes in Walls: Eyebolt with reinforcing bar fastening insert. Two-inch (50-mm) diameter eye, 1 in. (25 mm) by 4-in. (100-mm) bolt. Working load embedded in 6 in. (150 mm), 4000 psi (27.6 MPa) concrete: 13,000 lb. minimum tension.

Pulling and Lifting Irons in Floor: ⅞ in. diameter (21 mm), hot-dipped galvanized, bent steel rod, stress relieved after forming and fastened to reinforced rod. Exposed triangular opening. Ultimate yield strength: 40,000-lb. shear and 60,000-lb. tension.

Bolting Inserts for Cable Stanchions: Flared, threaded inserts of noncorrosive, chemical resistant, nonconductive thermoplastic material; ½ in. (12 mm) internal diameter by 2-¾ in. (68 mm) deep, flared to 1-¼ in. (30 mm) minimum at base. Tested ultimate pullout strength: 12,000-lb. minimum.

Expansion Anchors for Installation After Concrete is Cast: Zinc-plated carbon-steel wedge type with stainless-steel expander clip ½ in. (12 mm) bolt size, 5,300 LB rated pull-out strength, and 6,800 LB rated shear strength minimum.

Cable Stanchions: Hot-rolled, hot-dipped galvanized steel punched with holes for cable arm attachment.

Cable Arms: Hot-rolled, hot-dipped galvanized sheet steel pressed to channel shape, approximately two, 12 in. (300 mm) wide by 14 in. (350 mm) long and arranged for secure mounting in horizontal position at any position on cable stanchions.

Ground Rods: Solid copper clad steel, 3/4-in. diameter by 10-ft (3 m) length.

Ground Wire: Stranded bare copper, No. 6 AWG minimum.

Duct Sealing Compound: Non-hardening, safe for human skin contact, NOT deleterious to cable insulation, workable at temperatures as low as 35°F (1°C), withstands temperature of 300°F (149°C) without slump, and adheres to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and the common metals.

Expansion Plugs: Expansion plugs shall be constructed of polypropylene and equipped with neoprene or polypropylene gaskets. The plugs shall NOT be deleterious to the cable insulation. Expansion plugs shall be removable. Plugs installed in empty conduits shall have a pull rope attachment point.

Handholes: Handholes shall be as shown on the drawings. The handhole and its cover shall be designed in accordance with AASHTO requirements for HS20-44 truckload rating. The handholes and covers shall be capable of withstanding imposed lifting and handling loads.

## PART 3--EXECUTION

### INSTALLATION:

Install and support conduit, tubing, and duct products as indicated on the drawings in accordance with manufacturer's written instructions, applicable requirements of NEC, and National Electrical Contractors Association's "Standard of Installation". Comply with recognized industry practices to ensure that products serve intended functions.

Where mounting channel is used, all exposed ends shall be capped. All above grade, exposed conduit shall be anchored to mounting channels a minimum of 12 inches long.
Provide flexible conduit for motor connections, and for other electrical equipment connections where subjected to movement or vibration.

Provide liquid-tight flexible conduit for connection of motors and for other electrical equipment where subject to movement or vibration, and also where subjected to one or more of the following conditions:

1. Exterior locations
2. Moist or humid atmospheres where condensation can be expected to accumulate.

Rigid conduit (RGS and IMC) joints shall be cut square, reamed smooth in accordance with the NEC requirements. Joints shall be threaded and drawn up wrench tight in accordance with ASME B1.20.1. Bends or offsets shall be made with standard conduit bending dies that will NOT injure or flatten the pipe.

Rigid conduit terminating at cabinets and boxes shall be rigidly secured with locknuts inside and outside.

Male threads on exterior runs of galvanized steel conduits shall be thoroughly coated with a conducting sealing media such as petroleum base products. No red lead shall be used on any conduit joint.

All conduit penetrations through building walls, fire walls, or floors shall be sealed around outside of conduits with sealant appropriate for wall material (i.e., grout for concrete walls, fire stop caulk for drywall, etc.). Conduit penetrating exterior walls shall be internally weather sealed. Conduits 2 in. or greater, passing through fire floors, shall have UL or FM approved internal fire seals.

All raceways entering service entrance equipment, switchgear or motor control centers from service conduit shall be sealed using a removable expansion plug or fire-rated material. The seal shall be installed at the exterior entrance to prevent animal entrance into the raceway system. All empty and spare raceways shall be plugged on both ends with a removable plug.

Conduit Indentification: Label conduits per Section 16195--Electrical Identification.

Underground Ducts: All underground ducts shall be installed in locations shown on drawings, enclosed in a red concrete casing. Ducts shall be sloped towards manholes in order that all ducts will properly drain. The concrete casing shall also enclose all standard conduit bends or elbows. All underground ducts shall have steel reinforcement under roads and heavy traffic areas in sizes as shown on the drawings.

Excavate the trenches to provide elevation on top of concrete envelope as shown on drawings. After trenches are excavated and graded, the duct shall be laid in rows on plastic spacers.

Spacers shall be placed so that each section of duct is supported at intervals as specified in NFPA 70 (NEC). Concrete shall then be placed per Section 03300—Cast-in-Place Concrete until the ducts are covered to the required depth and leveled, leaving NOT less than 3 in. of concrete over top tier of ducts.

All trench work shall be back-filled and compacted per Section 02200--Earthwork.

Manhole Installation: Cables shall be racked in manholes and handholes to meet the cable manufacturers bending radius requirements.

Communication cables shall NOT be installed in manholes with power cables.

Elevation: Install manholes at the grade indicated on the drawings. The top of handhole lids shall be at grade unless otherwise indicated on the drawings.

Access: Install cast-iron frame and cover. Install grade ring to support frame and cover and to connect cover with roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to grade ring.

Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. After ducts have been connected and grouted, and prior to backfilling, waterproof joints and connections and touch-up abrasions and scars. Waterproof exterior of manhole grade rings after mortar has cured at least 3 days.

Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.

Grounding: Ground exposed metal components and hardware with No. 6 AWG minimum bare copper grounding conductor to manhole ground bus. Turn conductors neatly around corners. Install on walls and roof using cable clamps secured with expansion anchors. Install 3/4 inch by 10 ft. ground rod through the floor of each manhole. Connect with a #6 AWG minimum bare copper ground conductor to the manhole ground bus.

Pre-cast Concrete Underground Structure Installation: Install as indicated, according to manufacturer's written instructions and ASTM C 891. Install units plumb and level and with orientation and depth coordinated with arrangement of connecting ducts to minimize bends and deflections required for proper entrances. Support units on a level bed of crushed stone or gravel, graded from the 1 in. (25 mm) sieve to the No. 4 sieve and compacted to same density as adjacent undisturbed earth.

Duct Entrances to Manholes: Space end bells approximately 10 in. (250 mm) on center for 5 in. (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 ft (3 m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances.

Labels: Label each manhole inside the extension ring with 3-inch high letters indicating the proper direction (N, S, E, W).

FIELD QUALITY CONTROL TESTING:

Subcontractor Inspection and Testing: The Subcontractor or his agents shall perform visual inspections to determine that equipment installation conforms to the NEC, these specifications, and the drawings.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work with the drawings and specifications.

END OF SECTION 16110

# SECTION 16120--CABLE, WIRE, CONNECTORS AND MISCELLANEOUS DEVICES

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall furnish, install, and terminate all cables, conductors, and devices to make complete and operational systems for this project.

Section Includes, but is NOT limited to the following:

Provide and install cables, wires, and wiring connectors of sizes, ratings, materials and types as specified on the drawings.

Related Sections: See other related sections for specific cables, wire, labels, and testing requirements.

16000 Electrical General Provisions
16195 Electrical Identification

### REFERENCES:

The following documents, including others referenced therein, form part of this specification to the extent designated. Unless otherwise indicated, use the latest edition in effect as of the date of this specification.

INSTITUTE OF ELECTRICAL & ELECTRONICS ENGINEERS INC. (IEEE)

IEEE 576 Recommended Practice for Installation, Termination, and Testing of Insulated Power Cables as Used in the Petroleum and Chemical Industry

NATIONAL ELECTRICAL CABLE ASSOCIATION (NECA)

Standard for Installation Practices

UNDERWRITERS LABORATORIES, INC. (UL)

UL 1581 Electrical Wires, Cables, and Flexible Cords

SUBMITTALS:

Submittals include, but are not limited to the following:

Megger test procedure and test results
Continuity test procedure and test results

See Section 01300, Submittals and the Vendor Data Schedule, for additional submittal requirements.

PART 2--PRODUCTS

WIRING MATERIALS, 600 V:

Conductors shall be stranded for all sizes of wire and cable larger than 10 AWG.

Conductors shall be copper for all sizes.

Wire insulation shall be Type THHN/THWN or XHHW for all 600 V conductors unless otherwise noted.

Minimum size of power conductors shall be No. 12.

Wiring shall be color-coded as indicated in the table below:

Conductor Code Color

| Conductor | 208/120 Volts* | 480/277 Volts | 240/120 Volts* |
|---|---|---|---|
| Phase A | Black | Yellow | Black |
| Phase B | Red | Orange | Red |
| Phase C | Blue | Brown | |
| Neutral | White | Gray | White |
| Ground | Green | Green | Green |

* For new circuits installed in existing panels only, black may be used for any phase conductor, white for neutral and green for ground.

Use appropriate colors of plastic tape or sleeves to identify conductors larger than #10 AWG NOT furnished with colored insulation. Yellow phase tape shall consist of two separate bands at each application point to avoid confusion with white, gray, or orange after aging. All wire markers and phase tape shall be covered by clear heat-shrink sleeving.

Wire #10 AWG and smaller shall be furnished with continuous colored insulation for all power, neutral and ground conductors when multiple circuits are installed to identify the

phase connected to, neutral, or equipment ground wiring. Bare copper conductors shall only be used for ground conductors as shown on the drawings.

CONNECTORS:

All connections shall be tightened to the manufacturer's published torque values. Where manufacturer does not specify torque requirements, connections shall be torqued to values specified in UL 486A.

Connectors shall only be used as specified by manufacturer.

Spring type pressure connectors, such as "Scotchlock," shall be used for splicing No. 8 AWG and smaller.

Splitbolt and/or lug type connectors such as "Burndy" shall be used for splicing No. 6 AWG and larger.

Scotch mastic pads and two layers of half wrapped electrical tape shall be installed over all splitbolt connectors.

Splices in manholes or handholes shall be Scotchcast Power Cable Splice Ket #82-A series.

Crimp on spade or ring-tongue lug connectors shall be used for connection to terminal boards such as "Stakon."

Wire/Device Identification: See Section 16195-Electrical Identification.

MISCELLANEOUS DEVICES:

Thermostat: The thermostat for controlling the head bolt heater power shall be used to monitor ambient temperature. The thermostat shall have a range of 15-100$^{O}$F and shall have a single pole, double throw switch. The adjustment mechanism shall be located to deter tampering. The enclosure shall be NEMA-4X. Reychem AMC-1A (UE).

Contactor: The contactor associated with the head bold heater power shall be a 3 pole, 100-ampere, non-reversing type. The contactor shall be rated at 600 V and contain a control power transformer to supply 120 VAC. The primary of the transformers shall be fused and the secondary shall be fused and grounded. The contactor shall be equipped with a Hand-Off-Automatic switch and shall be wired such that when the temperature falls below a pre-set point, power will be supplied to the head bolt heater panel. The contactor and associated equipment shall be housed in a NEMA 3R enclosure. Cutler-Hammer Type ECLO3.

PART 3--EXECUTION

INSTALLATION:

General: Install electrical cable, wire, and connectors as follows:

1. As specified on the drawings.
2. As specified in manufacturer's written instructions.
3. As specified in applicable requirements of NEC and NECA's "Standard of Installation".
4. In accordance with recognized industry practices to ensure products serve their intended functions.

Coordinate cable and wire installation work with electrical raceway and equipment installation work as necessary for proper interface.

Bundle and form wires inside wireways, panel boards, control panels, junction boxes, etc. to clear pinch points, hinges, screws and clamps associated with the enclosure cover.

Pull conductors at the same time if more than one is being installed in a raceway.

Use pulling methods including fish tape, cable, or rope that cannot damage raceway. Any conductors that require mechanical assistance in pulling shall be installed in accordance with IEEE 576.

Install splices and taps that have a mechanical strength and insulation rating equivalent to, or better than, the conductor.

Use splice and tap connectors that are compatible with conductor material.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing:

Meggering: Prior to terminating, test any cable or wire 25 ft. or more in length for insulation resistance using the megger (500 V megger for 300 V insulation and 1000 V megger for 600 V insulation). Any wire identified with less than 10 megohms to ground or other conductors shall be replaced before proceeding with the terminating process. List the tested conductors on the required Test Data Submittal Sheet. An alternate megger test voltage can be used as recommended by the manufacturer for the specific cable or wiring.

Electrical Continuity: Complete an electrical continuity test on each conductor as follows:

1. Before termination of conductors to terminals or devices.
2. After the conductor connectors have been installed.
3. After the conductors have been labeled.

Use a battery-powered buzzer or calibrated ohmmeter to determine if all power, control, grounding, and other conductors are properly installed and identified. List all conductors that were tested on the required Test Data Submittal Sheets. The Subcontractor is required to provide the Test Data Submittal Sheets.

Contractor Inspection and Testing: Wire and cables shall be checked for proper termination and termination tightness. The Contractor's Representative shall witness torquing of all connections unless indicated otherwise.

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16120

# SECTION 16123--FIBER OPTIC CABLE INSTALLATION

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall furnish, install, and test optic cables as shown on the drawings and described in this specification.

The Subcontractor shall provide all qualified labor, tools, materials needed to complete the installation, and testing of the fiber optic cable. The Subcontractor shall ensure that the signal loss is less than the maximum allowed.

The Subcontractor shall submit a test procedure for testing all fiber optic cables within this project for review and approval prior to use.

The Subcontractor shall ensure that the use of the installation devices and test equipment is operated as directed by the equipment manufacturer. Verification of training on the instrumentation to be used in the installation, termination, and testing of the fiber optic is required to be submitted to the Contractor. Fiber optic cable installers will be required to provide evidence of a current BICSI Installer level certification. All Subcontractor personnel splicing, terminating and testing fiber optic cable will be required to provide evidence of current BICSI Technician level certification or approved.

### QUALITY CONTROL:

#### Codes and Standards:

The latest edition of the document in effect on the date of invitation to bid shall apply to the work described herein. In the event of conflict between the documents referenced and the contents of this Specification or the Drawings, this Specification and the Drawings shall govern.

ELECTRONICS INDUSTRY ASSOCIATION (EIA)

| | |
|---|---|
| EIA - 440 | Fiber -optic Terminology |
| EIA - 455 | Standard test procedures for fiber-optic fibers, cables, transducers, connecting and terminating devices |
| EIA - 458 | Optical waveguide material, classes, and preferred sizes |
| EIA - 475 | Fiber-optic connections - generic specifications |
| EIA - 509 | Fiber-optic terminal device - generic specifications |
| EIA - 526 | "Standard Test Procedure for Fiber-Optic Systems" |

Components and installation shall comply with applicable requirements of the Electronics Industry Association (EIA) Standards EIA-440, -455, -458, -475, -509 and -526 pertaining to optical-fiber cable and system component construction and installation.

The fiber optic installation shall conform to the National Electrical Code NFPA 70 Article 770, and the American National Standards Institute (ANSI) Fiber Distributed Data Interface (FDDI) Physical Media Document.

SUBMITTALS:

See the Vendor Data Schedule.

Product Data: The Subcontractor shall submit catalog cut sheets which show as a minimum the complete operating specification of all items to be purchased under the requirements and all instruments which will be used in the installation and testing of the fiber optic cable.

PART 2--PRODUCTS

GENERAL:

The Subcontractor shall furnish all labor, materials, equipment and appliances required to complete the installation of the fiber optic cable. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Code NFPA 70, the National Electrical Safety Code (NESC), and fiber distributed data interface (FDDI).

MATERIALS:

The cable shall be 9/125 single-mode and have the number of fibers as specified on the drawings

Fiber optic cable shall be Optical Cable Corporation DX series riser rated tight buffered distribution cable.

No chemicals shall be required to remove the fiber coating in order to install a connector. Each fiber shall be uniquely marked. This may be a color code or a numeric marking at least once per foot of length.

The cable shall be of all dielectric construction.

CONDITION OF PRODUCTS:

Except as otherwise indicated, provide new electrical products, free of defects and harmful deterioration at the time of installation. Provide accessories and assembly devices recognized as integral parts of the product or as required by governing regulations.

Unless otherwise indicated by the drawings or specifications or approved in writing, the materials and/or equipment furnished under this specification shall be the standard product of manufacturers regularly engaged in the production of such equipment, and shall be the manufacturer's standard design.

## PART 3--EXECUTION

### INSTALLATION:

General: Install the fiber optic cable as indicated on the drawings, in accordance with the fiber optic cable manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation," and in accordance with recognized industry practices to ensure products serve the intended functions.

### FIBER OPTIC CABLE INSTALLATION:

The fiber optic cable shall be installed to meet the recommendations of the cable manufacturer.

The pulling force applied to the cable shall not exceed the force stated by the cable manufacturer as the maximum force applied during installation. A calibrated dynamometer shall be used to measure the pulling force applied to the fiber optic cable when pulling equipment is used. The Contractor's representative shall witness the use of the dynamometer.

The bending of the fiber optic cable during installation shall not be less than the minimum bend radius specified by the fiber optic cable manufacturer.

### FIBER OPTIC CABLE LOSS:

The loss for any of the optic fibers signal shall be 1 dB maximum.

### SUBCONTRACTOR RESPONSIBILITY:

The Subcontractor shall provide all tools and equipment needed to complete the installation and testing of the fiber optic cable. The Subcontractor shall make certain that the signal loss is less than the maximum allowed.

All tools purchased for this Subcontract shall be turned over to the Operating Contractor at the completion of the Subcontract.

The Subcontractor shall make certain that the use of installation devices and test equipment are operated as directed by the equipment manufacturer. Training in the use of the instrumentation which is to be used in the installation, termination, and testing of the fiber optic cable is required. The Subcontractor shall certify that each person who will perform a

fusion splice or test the transmission properties of the fiber optic cable has been properly trained in the use of the equipment used. The vendor data submittal shall state the type of training, the date, and the trainer.

QUALITY CONTROL TESTING:

Subcontractor Supplied Testing: The Subcontractor shall test all of the fiber optic cable installed or modified by the project prior to closeout. As a result of testing, those items found to be unacceptable shall be repaired and re-tested at the Subcontractor's expense. This procedure shall continue until the item is shown to be acceptable. The Subcontractor shall coordinate testing with the Contractor, and schedule the test in writing a minimum of two weeks in advance.

All test equipment shall be checked for proper calibration by the Contractor's Representative prior to and during testing. Any test equipment (OTDR or Power Loss Meter) found out of calibration prior to or during testing shall be calibrated at the Subcontractor's expense.

The Subcontractor shall submit a test procedure for each of the following field tests:

Fiber Optic Test: The Subcontractor shall perform a bi-directional fiber optic loss test at 1300 and 1550 nm for single-mode fibers with an OTDR to evaluate the installation of cable. The Subcontractor shall not connect the OTDR directly to the fiber under test, but shall ensure that a launch cable is used in accordance with the OTDR manufacturer's recommendations. Results of the test shall be submitted on the fiber optic test report. A copy of the OTDR signature traces for each fiber cable shall be submitted with the fiber optic test report.

Optical Loss Test: The Subcontractor shall perform a bi-directional fiber optic segment test to verify proper operation. The signal loss shall be measured with a calibrated power measurement meter. The maximum fiber segment loss shall be 1 dB. The test shall be performed at 1300 nm and 1550 nm. This test form shall be submitted.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16123

# SECTION 16124--INSULATED MEDIUM VOLTAGE CABLE, AND CONNECTORS

## PART 1--GENERAL

### SUMMARY

This section includes single and multiple conductor cables, cable splices, terminations and accessories for medium voltage cables.

Work includes, but is not limited to:

Provide and install 15 kV cable and connectors of the types specified herein and as shown on the drawings.

Related Sections:

16000 Electrical General Provisions
16120 Cable, Wire, Connectors and Miscellaneous Devices
16195 Electrical Identification
16462 Transformers, Oil Filled, Pad Mounted, Power

### SUBMITTALS:

Cable and Terminations: Submit catalog data for cable and terminations.

### QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

Codes and Standards: See Section 16000, Electrical General Provisions.

Electrical Component Standard: Installation shall comply with NFPA 70 "National Electrical Code.

IEEE Compliance: Comply with applicable IEEE standards including C2 "National Electrical Safety Code".

UL Compliance: Cables and connectors shall each be listed and labeled by UL.

Single Source Responsibility: All medium voltage cable shall be the product of a single manufacturer.

Installer Qualifications: Engage an experienced Installer of medium-voltage electrical cable to perform the installation specified in this section. In addition, for the specific work of cable

splicing and terminating, engage Installers who are experienced in cable splices for the specific types of cable and cable accessories specified in this Section.

Tester Qualifications: Engage a cable tester currently certified by NETA or National Institute for Certification in Engineering Technologies to supervise on site testing.

DELIVERY, STORAGE, AND HANDLING:

Deliver medium-voltage cable on factory reels conforming to NEMA WC26. Store cable reels on elevated platform in a dry location. Cable ends shall be checked for watertight seals. Reel ends of cables shall be immediately resealed after cutting to eliminate intrusion of moisture. Cable jackets subject to ultra-violet degradation shall be stored indoors.

PART 2--PRODUCTS

MATERIALS:

MEDIUM-VOLTAGE CABLE:

General: Cable shall be single- and multi conductor types, with types and size as indicated on the drawings, and conforming to UL Standard 1072, "Medium Voltage Power Cables". Approved cable manufacturers are; Okonite Co., Rome Cable Co. and Kerite Co. (Hubble).

Cable Type MV-90: Cable Type MV-90 shall be EPR insulated and shall conform to NEMA Standard WC8 (1CEA S-68-516) Ethylene - Propylene Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy unless otherwise shown on the drawings.

Conductors: Class B stranded, annealed copper.

Cable Jacket: Polyvinyl Chloride

Metallic Shielding: Copper shielding tape, helically applied over semiconducting insulating shield.

Cable Voltage Ratings: 15 kV phase-to-phase as shown on the drawings and in accordance with the referenced standard.

Insulation Thickness: Corresponding to 133% insulation level in accordance with the referenced standard unless shown otherwise on the drawings.

SPLICING AND TERMINATING PRODUCTS:

General: Comply with the following standards:

IEEE 48: "IEEE Standard Test Procedures and Requirements for High-Voltage Alternating Current Cable Terminations."

IEEE 400: "Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field."

IEEE 404: "Standard for Power Cable Joints."

IEEE 592: "Standard for Exposed Semiconducting Shields on Premolded High-Voltage Cable Joints and Separable Insulated Connectors."

UL 486A: "Wire Connectors and Soldering Lugs for Use with Copper Conductors."

Types: Compatible with the cable materials.

Connectors: Compression type as recommended by cable or splicing kit manufacturer for the application.

Splicing and Terminating Kits: As recommended by the manufacturer in writing for the specific sizes, ratings, and configurations of cable conductor, splices, and terminations specified. Kits shall contain all components required for a complete splice or termination including detailed instructions and shall provide insulation equivalent to the insulation class of the cable it connects. Splices shall be made with standard splicing kits and shall be of the following manufactures: Thomas and Betts, Raychem heat shrink.

Conductor Terminations, General: Comply with Class 1, 2, or 3 of IEEE Standard 48, as indicated. Insulation class shall be equivalent to that of the cable upon which they are installed. Terminations for shielded cables shall include a shield grounding strap. Class 2 terminations and nonshielded cable terminations shall include an effective moisture seal for the end of the insulation whether or not this item is included in terminations kits. Seal shall be cold shrink rubber sleeve, or heat shrink sleeve as recommended by the kit manufacturer. Termination kits shall be performance tested for compliance with IEEE Standard 48 and shall be of the following types:

Class 1 Termination for Outdoor Shielded Cable: Heat-shrinkable type with heat-shrinkable inner stress control and outer non-tracking tubes, multiple molded non-tracking skirt modules, and compression-type connector.

Class 1 Termination for Indoor Shield Cable: Furnished as a kit with stress relief tube, non-tracking insulator tube, shield ground strap, compression-type connector, and end seal.

Separable Insulated Connectors: Modular system, complying with IEEE Standard 386, "Separable Insulated Connectors for Power Distribution Systems above 600V". System shall consist of disconnecting, single-pole cable terminators and matching stationary, plug-in, dead-front terminals. System components shall be designed for the system voltage and for sealing against moisture and shall conform to the following:

Cable Termination at Equipment: (Such as transformers or switchgear): Elbow-type terminators that mate with bushing terminals in the equipment.

Load-Break Cable Terminators: Elbow-type units with 200-ampere load make/break and continuous current rating as shown on the drawings. Each terminator shall be coordinated with insulation diameter and conductor size and material of cable being terminated. Terminator body shall have capacitively coupled test point. Load Break elbows shall be sized to mate with existing sectionalizing Terminal as shown on drawings.

Dead-Break Cable Terminators: Elbow-type unit with 600 ampere continuous current rating designed for de-energized disconnecting and connecting coordinated with insulation diameter and conductor size and material of cable being terminated. Include capacitively coupled test point on terminator body.

Grounding Kit: Grounding kit shall include jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three-phases of feeders, and carrying case.

## PART 3--EXECUTION

### EXAMINATION:

Examine raceways and other cable installation locations for cleanliness of raceways, minimum bending radii of cables, and conditions affecting performance of cable installation. Pull a mandrel through raceways to check for raceway blockages and cleanliness. Do not proceed with cable installation until satisfactory conditions have been achieved.

### INSTALLATION:

General: Install cable accessory items in accordance with manufacturer's written instructions and as indicated.

### INSTALLATION OF CABLES:

Install cable in accordance with manufacturers written instructions and at locations shown on the drawings.

Pull Conductors Simultaneously: Conductors in the same raceway shall be pulled simultaneously. Use UL-listed and manufacturer-approved pulling compound or lubricant

where necessary. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values for multi conductor installation. Where only single cable maximum values are provided by the manufacturer use only 70% of the maximum tension and sidewall pressure value.

Use Pulling Means: Use pulling means including, fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceways. Do not use rope hitches as the pulling attachment to cable.

Install Exposed Cable: Install exposed cable parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

INSTALLATION OF TERMINATIONS:

Install Terminations: Install terminations at ends of conductors and seal multi conductor cable ends with standard kits. Conform to manufacturers written instructions. Comply with classes of terminations indicated. Cables not terminated within 3 hours shall be sealed to eliminate the entrance of moisture.

Tighten Electrical Connectors and Terminals: Tighten electrical connectors and terminals in accordance with manufacturer's torquing requirements. If requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A.

INSTALLATION OF CABLE ACCESSORIES:

GROUNDING:

Ground shields of shielded cable at terminations, splices, and separable insulation connectors. Ground metal bodies of terminators, splices, cable and separable insulated connector fittings, and hardware in accordance with manufacturers written instructions.

IDENTIFICATION:

Identify cable in accordance with Section 16195, Electrical Identification.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing Procedure:

Test Objectives: To ensure cable installation, including cable accessories, is operational within industry and manufacturer's tolerances, is installed in accordance with Contract Documents, and is suitable for energizing.

Procedures: Comply with International Electrical Testing Association (NETA) standard, "Acceptance Testing Specifications for Electrical Power Distribution Equipment and

Systems", Section 7.3.2, Cables, Medium Voltage and IEEE 400. Upon satisfactory completion of tests, attach a label identified by cable pull sheet number to tested components.

Tests: After the termination kits are installed, but prior to terminating at the equipment, the Subcontractor will perform cable testing. Coordinate the testing with the Operating Contractors Power Management group.

The Subcontractor shall maintain a written record of observations and tests, report defective materials and workmanship, and retest corrected defective items. Subcontractor shall submit written reports to the Contractor Representative.

The Contractor's Representative shall be informed of all cable test a minimum of 72 hrs in advanced of any cable testing. The Contractor Representative shall witness or waive the right to witness field tests and inspect the installation to determine compliance with the specifications and drawings.

If any conductor in a pull group fails the test then all conductors in that pull group shall be removed and replaced at the Subcontractors expense.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16124

# SECTION 16160--PANELBOARDS

## PART 1--GENERAL

### SUMMARY:

Provide and install distribution and power panelboards of sizes, ratings, materials, and types as shown on the panel schedules. Panelboards shall be equipped with thermal-magnetic, molded case circuit breakers of trip ratings as shown on the panel schedules.

Section Includes, but is not limited to:

Furnish and install the panelboards shown on drawings and specifications including the following:

- Enclosures
- Bus bars
- Breakers
- Covers
- Circuit directories
- Wire labeling

Terminate all conductors inside enclosures.

Furnish and install the mini-power center to supply 120V receptacles for the head bolt heaters.

Related Sections:

- 16000 Electrical General Provisions
- 16195 Electrical Identification
- 16450 Grounding

### REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

| | |
|---|---|
| NECA | Standard of Installation |

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA 250 | Enclosures for Electrical Equipment (1000 Volts Maximum) |
| NEMA AB 1 | Molded Case Circuit Breakers |
| NEMA ICS 2 | Industrial Control Devices, Controllers and Assemblies |
| NEMA ICS | Terminal Blocks for Industrial Control Equipment and Systems |
| NEMA KS 1 | Enclosed and Miscellaneous Distribution Equipment Switches (600 volts maximum) |
| NEMA PB 1 | Panelboards |
| NEMA PB 1.1 | Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less. |

NATIONAL FIRE PROTECTION ASSOCATION (NFPA)

NFPA 70 National Electrical Code (NEC)

UNDERWRITERS LABORATORY

UL 67

SUBMITTALS:

Submittals include, but are not limited to the following:

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

NFPA 70
NECA Standard of Installation
NEMA 250
NEMA AB
NEMA ICS 2
NEMA ICS 4
NEMA KS 1
NEMA PB 1
NEMA PB 1.1

PART 2--PRODUCTS

MATERIALS

Bussing Assembly and Temperature Rise: All bussing shall be copper. Panelboard bus structure and main lugs or main breaker shall have current ratings as shown on the panelboard schedule. Such ratings shall be established by heat rise tests with maximum hot spot temperature on any connector or bus bar (NOT to exceed 50°C rise above ambient.) Heat rise tests shall be conducted in accordance with UL Standard 67. The use of conductor dimensions will NOT be accepted as a substitute or replacement of actual heat tests. All panelboards must have ground and neutral bus installed.

Molded Case Circuit Breakers: Circuit breakers shall meet the requirements of Standard NEMA AB 1 with integral thermal and instantaneous magnetic trip in each pole. Circuit breakers shall be equipped with individually insulated, braced, and protected connectors. The front faces of all circuit breakers shall be flush with each other. Large, permanent, individual circuit numbers shall be affixed to each breaker in a uniform position. Tripped indication shall be clearly shown by the breaker handle taking a position between "ON" and "OFF". Provisions for adding more breakers must NOT require additional connectors.

Integrated Equipment Short Circuit Rating: Each panelboard, as a complete unit, shall have a factory established short circuit current rating equal to, or greater than, the integrated equipment rating shown on the panelboard schedule or on the drawings. This rating shall be established by factory testing with the overcurrent devices mounted in the panelboard. The short circuit tests on the overcurrent devices and on the panelboard structure shall be made simultaneously by connecting the fault to each overcurrent device with the panelboard connected to its rated voltage source. Method of testing shall be per UL Standard 67. The source shall be capable of supplying the specified panelboard short circuit or greater. Factory testing of panelboard overcurrent devices for short circuit rating only while individually mounted is NOT acceptable. In addition, testing of the bus structure by applying a fixed fault to the bus structure alone is NOT acceptable. Panelboards shall be factory marked with their maximum short circuit current rating at the supply voltage and shall be UL listed.

Mini-Power Center: The mini-power center located in the south end of the SSSTF will provide power to the head bold heaters. The power center shall consist of a primary main circuit breaker, a 30 KVA transformer to transform the incoming 480 V, three phase, three wire feed to a 208Y/120 Volt three phase, four wire secondary. The secondary side of the power center shall consist of a secondary main circuit breaker and branch circuit breakers as shown on the panel schedule.

Cabinet: Panelboard assembly shall be enclosed in a steel cabinet. The rigidity and gauge of steel shall be as specified in UL Standard 50 for cabinets. The size of wiring gutters shall be in accordance with UL Standard 67. Cabinets shall be equipped with latch and tumbler-type lock on door of trim. Doors over 48" long shall be equipped with three-point latch and vault lock. All locks shall be keyed alike. Endwalls shall be removable. Finish shall be gray-

backed enamel electrodeposited over clean phosphatized steel. A circuit directory frame and card with a clear plastic covering shall be provided on the inside of the door. Panelboards installed in exterior locations shall be NEMA 3R rated.

Safety Barriers: The panelboard interior assembly shall be dead front with the panelboard front removed. Main lugs or main breakers shall have barriers on five sides. The barrier in front of the main lugs shall be hinged to a fixed part of the interior. The end of the bus structure opposite the mains shall have barriers.

UL Listing: Panelboards shall be listed by Underwriters Laboratories and shall bear the UL label. When required, panelboards shall be suitable, and marked in orange letters, for use as service equipment.

## PART 3--EXECUTION

### INSTALLATION:

Install panelboards as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation," and complying with recognized industry practices to ensure that products serve intended functions.

Provide electrical connections within enclosures.

Provide filler plates for unused spaces in panelboards. Provide typed circuit directory for each branch circuit, indicating the area and function served by each breaker. Revise directory to reflect circuiting changes required to balance phase loads. Provide engraved nameplates in accordance with Section 16195.

Ground and bond panelboard enclosures according to the NEC and Section 16450 of this specification.

### FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: Visually inspect panelboards to ensure that equipment installation conforms to NEC, these specifications, and the drawings. Measure steady state load currents at each panelboard branch circuit; rearrange circuits in the panelboard to balance the phase loads to within 20% of each other. Maintain proper phasing for multi-wire branch circuits.

Contractor Inspection and Testing: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

CLEANING:

All panelboards, especially those with knockouts removed or holes sawed in the enclosure, shall be thoroughly cleaned and vacuumed to ensure all metal scraps and shreds are removed before the panel is energized and the cover is installed.

END OF SECTION 16160

# SECTION 16195--ELECTRICAL IDENTIFICATION

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall provide and install labels and identification as specified in this document and on the associated drawings. See electrical drawings for equipment identifiers.

Section Includes, but is not limited to:

Install labels on electrical and related equipment, including the following:

- Wires
- Cables
- J-Boxes
- Switches
- Receptacles
- Panels
- Disconnects
- Transformers
- Poles
- Panelboards

Related Sections:

16000 Electrical Sections
16120 Cable, Wire, Connectors and Miscellaneous Devices

### REFERENCES:

The following documents, including others referenced therein, form part of this section to the extent designated herein. See the list of general electrical references in Section 16000.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI A13.1 Scheme for the Identification of Piping Systems

### SUBMITTALS:

Vendor data is not required for this section, unless an "or equal" item is proposed.

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

ANSI Standard A13.1 with regard to type and size of lettering for raceway and cable labels.
NFPA 70

PART 2--PRODUCTS

MATERIALS:

Adhesive Marking Labels for Raceway and Metal-Clad Cable: Pre-printed, flexible, self-adhesive labels with legend, identifying system type, or voltage and phase.

Wire and Cable Designation Tape Markers: Self-adhering, oil and moisture resistant, vinyl labels covered with clear heat shrink tubing. Letters shall be typed in black, non-smear ink. Hand lettered labels shall not be used. Engraved identification tags may also be used.

Engraved, Plastic-Laminated Labels, Tags, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-in. minimum thick for signs up to 20 sq. in., or 8 inches in length; 1/8-in. thick for larger sizes. Engraved legend and punched for mechanical fasteners.

Exterior Metal-Backed Butyrate Warning and Caution Signs: Weather-resistant, non-fading, pre-printed cellulose acetate, butyrate signs with 20 gauge, galvanized steel backing, with colors, legend, and size appropriate to the location. Provide ¼-in. grommets in corners for mounting.

Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 6/32 galvanized steel machine screws with nuts, flat washers, and lock washers. Signs and labels shall be glued in place using clean GE Silicone II adhesive. Duplex receptacles and light switches shall be glued on only. Labels larger than 1" high x 2" long shall be glued and screwed on.

LABEL MAKEUP, CONTENT, SIZE, AND LETTERING:

Labels for Electrical Equipment:

General: Labels are to be made from materials that are compatible with the application. Brass or stainless steel shall be used when indicated on the drawings.

Equipment Label Content: Include the following, as applicable, on electrical power-distribution equipment labels:

1. Properly assigned identifier (as shown on drawings)
2. Noun name or function description
3. Designation on system designator as assigned by INTEC
4. Equipment inventory number
5. Voltage and the number of phases
6. Power source (fed from) equipment identifier
7. Circuit number (if applicable)
8. Transformer and disconnect switch labels shall contain the destination (fed to) power equipment identifier fed by the transformer secondary or disconnect switch.

Example Panel Labels:

S-LP-WL-3901
LIGHTING PANEL, 408/277V, 3 PHASE
FED FROM: PANEL EP-2, CKT 2, WMF-603

N-PP-WL-3901
POWER PANEL, 480/277V, 3 PHASE
FED FROM: TRANSFORMER N-XFR-3901

Example Transformer Label:

N-XFR-WL-3901
TRANSFORMER
FED FROM: SECTIONALIZER ST-2
FEEDS: PANEL N-PP-3901

Example Disconnect Label:

N-DS-WL-3901
DISCONNECT SWITCH
FED FROM: PANEL N-PP-3901, CKT 4
FEEDS: HEATER HV-EHTR-3903

Equipment Label Colors: Background and legend colors for electrical equipment labels shall be as specified in Table I below.

Table I. Electrical Equipment Label Colors

| Power System Classification | Power System Designator | Background Color | Legend Color |
|---|---|---|---|
| Normal | N | black | white |
| Standby | S | yellow | black |
| Emergency | E | white | red |
| UPS | U | white | red |
| Regulated | R | same as source | same as source |
| Direct current | DC | black | white |

Equipment Label and Lettering Size: Electrical equipment label and lettering size shall be as specified in Table II. If equipment size constraints make the specified label size impractical, the label and lettering size will be as large as possible for that particular equipment application.

Table II. Electrical Equipment Label Sizes

| Table<br>Power Equipment Classification | Label Height (minimum) | Lettering Height First Line | Lettering Height Subsequent Lines |
|---|---|---|---|
| Primary Distribution Equipment | 2½ inch | ¾ inch | ⅜ inch |
| Secondary Power Distribution Switches | 1 inch | ⅜ inch | ¼ inch |
| Disconnect Switches | 1 inch | ⅜ inch | ¼ inch |
| Power Distribution Panels | 1 inch | ½ inch | ¼ inch |
| Power Distribution Transformers | 2 inch | ½ inch | ¼ inch |
| PCC/MCC Switchgear Switchboards | 2 inch | ¾ inch | ⅜ inch |
| Power Receptacles | ⅜ inch | 3/16 inch | N/A |

Identification and Labels for Circuits, Cables, and Wire: The method of identification shall be as follows:

Panelboard Breakers: Label single-pole breakers with the single-pole space numbers. Label double pole breakers with the first number of the two single spaces they occupy. Label three pole breakers with the first number of the three single spaces they occupy.

For example, a three-pole breaker in spaces 1, 3, and 5 shall be labeled breaker No. 1. A two-pole breaker in spaces 7 and 9 shall be labeled No. 7. A single pole breaker in space 11 shall be labeled No. 11. Install a type written circuit directory in each panel and furnish a copy to the Contractor.

Conductors: Conductor identification shall include the following:

1. Panel identifier
2. Circuit identification number from the panel with the destination equipment identifier
3. Voltage.

Example Conductor Label: A conductor from S-PP-2301, circuit No. 4, to S-DS-3901 would be identified with the identification number S-PP-2301-4/S-DS-3901, 120V.

Conductor Color Coding: Provide color-coding for secondary service, feeder, and branch circuit conductors throughout the project's secondary electrical system as specified in Section 16120.

Conduit Labels:

General: Identify conduit with a label attached parallel to or encircling the conduit. The label shall show a legend of the conductor characteristics, including the following:

1. Highest voltage level contained within the conduit
2. AC or DC current
3. Number of phases
4. Service type (FA for Fire Alarm, ENS for Emergency Notification, VP for Voice Paging, EVAC for Evacuation), if applicable.

Example Conduit Label: 120V, AC, 1 Ph, FA.

Label Color: Conduit labels shall be color-coded as specified in Table III below:

Table III: Conduit Label Colors

| Power Type | Background Color | Lettering Color |
|---|---|---|
| Normal Power | Orange | Black |
| Standby Power | Yellow | Black |
| Emergency Power | White | Red |

Labeling Size and Placement: The minimum letter height for content and identification labels of raceways and conduit shall be as specified in Table IV below. A letter size of at least one half the trade diameter is recommended for conduit. The label shall be as long as required to display the specified information.

Table IV. Conduit Label Sizes

| Raceway or Conduit Size (inches) | Minimum Height of Lettering (inches) |
|---|---|
| ¾ to 1¼ | ½ |
| 1½ to 2 | ¾ |
| 2½ to 6 | 1¼ |
| 8 to 10 | 2½ |
| Over 10 | 3½ |

Note: Size refers to the nominal diameter for conduit or the width of the raceway or cable tray.

PART 3--EXECUTION

INSTALLATION:

General: Install Equipment/System Circuit/Device Identification as follows:

Apply equipment identification labels of engraved plastic-laminate on electrical equipment, including the central or master unit of each electrical system and each sub breaker or controller. This includes medium and low-voltage power distribution/communication/signal/alarm systems. Match the text to terminology and numbering of the subcontract documents and shop drawings. Apply labels for each unit of the categories of electrical work listed below:

1. Panelboards, electrical cabinets, and enclosures
2. Access doors and panels for concealed electrical items
3. Components, wires and cables
4. Disconnect and safety switches
5. Transformers

Apply circuit/control/item designation labels of engraved plastic laminate for items listed below:

1. Disconnect switches
2. Breakers
3. Power distribution and control components

For panelboards, provide and install a framed and typed circuit schedule (directory) with explicit description and identification of items controlled by each individual breaker. Furnish a copy of the panel directory to the Contractor.

Install labels at indicated locations as well as convenient viewing locations, free of obstructions and interference from operations and maintenance equipment.

Sequence of Work: If identification is to be applied to surfaces that require a finish, then install identification after the finish work is completed.

Identification and Labeling of Electrical Equipment: Attach equipment label(s) on the front of electrical equipment in as visible a location as possible. Use separate labels to identify cautions or dangers required by code and as designated on the drawings.

Labeling of Light Switches and Receptacles: Light switches and single-phase receptacles shall be labeled to identify the source power panel, circuit number, and voltage. Attach labels securely on or at each receptacle. Use construction adhesive GE Silicone II to glue labels to the cover.

Identification and Labeling of Fire Alarm and Supervisory Equipment: Label fire alarm and supervisory equipment per Specification 16721--Fire Alarm and Supervisory System.

Identification and Labeling of Circuits, Cables, and Wire: Each individual circuit breaker in a panelboard shall clearly be identified by a circuit number appropriate to the individual panelboard. Identify circuits, breakers, or spaces that are spare, blank, or utilized for power distribution on the panel legend provided by the subcontractor or manufacturer.

Conductors to 120V light switches and 120V duplex receptacles do NOT need to be labeled.

Label individual switchgear cubicles/cells.

Each conductor or cable shall be clearly identified and labeled in electrical pull boxes or junction boxes. Engraved, laminated plastic identification tags are acceptable for this purpose when attached to each conductor.

Label exposed cables used for power distribution or instrumentation with the assigned identification number no less than every 100-ft for the total length of the cable. Individual conductors used for overhead power distribution shall be labeled at each termination point.

If field applied conductor color-coding is used, apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6-in. from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1-in. wide tape in colors as specified. Apply yellow phase tape consisting of two separate bands at each application point to avoid confusion with white, gray, or orange after aging. Do NOT obliterate or obstruct any cable identification markings when taping. Adjust

tape locations slightly to prevent such visual obstructions. All wire markers and phase tape shall be covered by clear heat shrink sleeving.

Below Grade Power Circuit Identification: Securely fasten identifying tags to cables, feeders, and power circuits in vaults, pull boxes, and junction boxes. Tags shall have an engraved legend corresponding with designations in specifications and drawings. Attach tags with either monofilament line, approximately 55-lb test, or one-piece of self-locking nylon cable ties. Tag cables at each entry and exit of the manhole or once in a pull box or J-Box.

Conduit Labeling: Exposed raceways and conduits shall be labeled within 3-ft of the power source and adjacent to process equipment; adjacent to each side of any penetration through floors, walls, or bulkheads. Place labels at intervals NOT to exceed 20-ft on straight runs of conduit.

Raceways and conduit shall be labeled at least once in each room through which they pass. For ease of identification, apply labels in a convenient and obvious location. Conduction ceiling space above suspended ceilings shall be labeled.

High Voltage Feeders: The following areas shall be identified:

- Exposed wall surfaces in close proximity to enclosed conduit running concealed within such walls.
- The entire surface of exposed conduit.

Apply identification to areas as follows:

1. Clean surface of dust, loose material, and oily films before painting.
2. Prime surfaces.
3. For galvanized metal, use single-component acrylic-vehicle-coating, formulated specifically for galvanized surfaces.
4. For concrete masonry units, use heavy-duty acrylic-resin block filler.
5. For concrete surfaces, use clear alkali-resistant alkyd binder-type sealer.
6. Apply one intermediate and one finish coat of orange-silicone alkyd enamel.
7. Apply primer and finish materials in accordance with manufacturer's instructions.

Labeling of Manholes and Handholes: Manholes and handholes shall have the properly assigned identifier indicated on the cover (see drawings for identifiers).

Label inside of manhole walls with a 6-inch high black letter stenciled onto the concrete wall approximately centered on the wall.

Label each wall with N for North, E for East, W for West, S for South to match survey coordinates.

Label inside of manhole entry with number label for the manhole as shown on the drawings.

Manhole entry label shall be 3-in. high with letters and numbers stenciled in black ink or paint.

Identification labels shall be permanently displayed on the cover (of the manhole, handhole, etc.) so they will be legible over the design life of the installation. Markings may be welded to, machined-in, engraved-in, or a metal tag bolted to the cover. Lettering shall be in capital letters.

Content Labels: Ensure that the covers of handholes, manholes, or similar access to operational equipment have the contents clearly identified. Keep content legends specific and as brief as possible (e.g., ELECTRIC, COMMUNICATIONS, etc). Write content legends in English.

Warning, Caution and Instruction Signs: Install warning, caution, and instruction signs as follows:

1. Where required by NEC
2. As indicated on the drawings
3. Where required to assure safe operations and maintenance of electrical systems and of the items to which they connect
4. Engraved plastic-laminated instruction signs displaying instructions, explanations, cautions, dangers, or warnings personnel may need for the safe operation of the specific system or equipment being operated
5. Butyrate signs with metal backing for outdoor locations.

Identify Junction and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, pre-printed on orange background. Attach labels on the outside of the box cover. Mount an engraved plastic laminate label, identifying the circuits contained in the box, to the box cover. For exposed locations, use pressure-sensitive plastic labels. Use similar labels and tags for concealed boxes.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: The Subcontractor or his agents shall perform the following tests:

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16195

# SECTION 16360--DISCONNECT SWITCHES 600 V AND LESS

## PART 1--GENERAL

### SUMMARY:

Section Includes: Work includes, but is not limited to providing and installing electrical disconnect switches of types, grades, and sizes as shown on the drawings. Provide complete assembly including, but not necessarily limited to hubs, fuses, and other components and accessories as needed for a complete system.

### SUBMITTALS:

No vendor data required for this Section unless an "or equal" item is proposed.

## PART 2--PRODUCTS

### MANUFACTURERS:

Acceptable Manufacturers: Square D, Cutler Hammer and General Electric.

### MATERIALS:

Disconnects: Disconnect switches shall be UL listed, NEMA type, heavy duty, single throw, fused or nonfused, and have current and voltage rating as shown on the drawings.

Switches shall be operated with external operating handle, which is an integral part of the box--not the cover. The operating mechanism shall be quick-make, quick-break and shall not be capable of being restrained by the operating handle during the opening and closing operation.

Dual interlocks shall interlock the switch box cover with the switch mechanism and shall prevent opening or closing the box cover when the switch contacts are closed and the switch mechanism is in the "ON" position. An interlock release shall be provided to defeat the interlocking mechanism and to permit opening the box cover when the switch contacts are closed. To defeat the interlock release and permit opening the box cover shall require an external hand tool.

Switch handles shall be designed for padlocking in the "OFF" position, locking the door closed to inhibit access to the switch. All current-carrying metal parts of the switch shall be enclosed.

PART 3--EXECUTION

INSTALLATION:

Install disconnect switches as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation," and comply with recognized industry practices to ensure that products serve intended functions.

Install disconnecting devices associated with motors within sight of the motor driven device where practical. In all cases the disconnecting device shall be clearly labeled to distinguish which motor/piece of equipment it disconnects.

LABELING:

For labeling requirements see Section 16195--Electrical Identification.

FIELD QUALITY CONTROL:

Site Tests: Visual inspection to determine that equipment installation conforms to NEC, these specifications and the drawings.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16360

# SECTION 16414--MEDIUM AND HIGH VOLTAGE POLE HARDWARE AND EQUIPMENT

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall furnish and install, power poles, line hardware, Insulators, pole line equipment and conductors to make complete and operational medium voltage distribution line.

Section Includes: Work includes but is not limited to:

Provide and install power poles, line hardware, insulators, and other line equipment as shown on the contract drawings.

Related Sections: See other related sections for specific cables, wire, labels, and testing requirements.

16000 Electrical General Provisions
16195 Electrical Identification

### REFERENCES:

The following documents, including others referenced therein, form part of this specification to the extent designated. Unless otherwise indicated, use the latest edition in effect as of the date of this specification.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| C2 | National Electrical Safety Code (NESC) |
| O5.1 | American National Standard for Wood Poles – Specification and dimensions |

AMERICAN SOCIETY OF TESTING MATERIALS (ASTM)

| | |
|---|---|
| A 153 | Zinc Coating (Hot Dip) on Iron and Steel Hardware |
| A 475 | Zinc Coated Steel Strand Wire |
| B 3 | Soft or Annealed Copper Wire |
| B 401 | Compact Round Concentric Lay Stranded Aluminum Conductors Steel Re-enforced ACSR |

RURAL UTILITIES SERVICE (RUS)

| | |
|---|---|
| REA D-804 | Specification and Drawings for 12.5/7.2 Line Construction |
| 1728F-700 | REA Specification for Wood Poles, Stubs, and Anchor Logs |
| 1728H-701 | REA Specification for wood Crossarms (Solid and Laminated), Transmission Timbers and Pole Keys |

SUBMITTALS:

Submittals include, but are not limited to the following:

Manufacturer Data on Tension Equipment
Sag Charts
Inspection Reports
Field Sag Data

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

PART 2--PRODUCTS

Wood Poles: Wood poles shall be douglas fir and meet or exceed the requirements of REA bulletin 1728F-700. Poles shall include butt plate and #6 AWG ground wire.

Crossarms: Crossarms shall be douglas fir and meet the requirements of REA bulletin 1728H-701.

Conductor: Conductor shall be #4 copper weld for the phase conductors and a #6 copper weld for the neutral conductor.

Strain Splices: Strain splices shall be Burndy YDS-R.

Ties and Grips: Side ties, top ties and Guy grips shall be Performed Line Products.

Strain Clamps: Dead End strain clamps shall be Anderson.

Insulators: Pin insulators shall be ANSI class 55-5 15kV "F" neck radio free type Porcelain insulators. Dead end insulators shall be ANSI class 52-1 or 52-9 with 5000 lb. proof test.

Insulator Pins: Crossarm and pole top insulator pins shall have nylon threads and shall be Chance 881AP and C206-0106P.

Crossarm Brace: Crossarm braces shall be Chance 6953.

Pole Bands: Pole bands shall be Chance C203-0187 type.

Anchors and Rods: Anchors shall be Cooper DA4P3 with 1-in. rod.

Stirrups and Connector: Stirrups and connectors shall be AMPACT sized according to the intended use.

Cutout and Arrestor: Combination cutout and arrestors shall be ABB type LBU-II 15kV, 300 Amp loadbreak, 300 continuous Amp disconnect with 15 kV metal oxide arrestor.

Ground Rod: Ground rod shall be 5/8-in. diameter and 10 ft. long copper clad steel.

Pole Labels: Pole labels shall be 1-5/8-in, black on yellow, horizontal "E-Z Tags" as manufactured by Almetec Industries

Miscellaneous Hardware: Other hardware not specifically addressed shall be RUS approved. Installation hardware such as bolts, washers, locknuts, spring clips and etc shall be used as shown in REA D-804.

## PART 3--EXECUTION

## INSTALLATION:

Materials and equipment shall be installed in accordance with the requirements of the National Electrical Safety Code (NESC), ANSI/IEEE Standard 524, manufacturer's written recommendations, NECA " Standard of Installation, and in accordance with recognized industry practices to insure products serve intended functions.

Insulators: Insulators shall be handled with care to avoid damaging the galvanizing or chipping or cracking the porcelain. After installation, insulators shall be free of grit and dirt, which could be a problem during subsequent operation.

Wood Poles: Wood poles shall be installed so they stand vertically with a maximum deviation from plumb at the top of pole less than 1/200 of pole height above ground. Guys, where required, shall be attached to an anchor at an angle of 45 degrees maximum to the horizontal. After conductors have been sagged, guys shall be tightened to cause no noticeable deflection in the poles. Depth of pole setting shall be not less than 10 percent of pole height plus 2 feet. Holes shall be large enough to admit the poles without forcing and allow the use of tools to tamp backfill. Poles shall be labeled as shown on drawings.

Conductors: Conductors shall be installed as shown on the drawings and in such a manner to prevent damage during installation. Conductors shall not be tramped on, run over by vehicles, or dragged over sharp rocks. The cable on each reel shall be inspected for cuts, kinks, or other damage. Damaged portions, crooked or imperfect splices in the conductor shall be cutout and the cable re-spliced. Conductors shall be kept off the ground during stringing operations. Conductors shall be pulled over suitable rollers or stringing blocks

properly mounted on the pole or crossarm, to prevent binding while stringing. Installation of the conductors shall be performed in accordance with manufacturer recommendations.

Conductors shall be strung by control-tension method using neoprene-lined double wall-wheel type tension stringing equipment. The equipment shall have groove sides that will in no way damage the conductor. It shall be of a type capable of maintaining preset tensions and pulling speed. Sufficient continuous tension shall be maintained to keep conductors clear of ground or obstructions that could damage the conductor or could be damaged by the conductor. Sheaves shall be designed and used so that the pulling lines do not damage the sheaves or deposit foreign matter in the liner which may damage the conductor or cause foreign matter to be deposited on the conductor.

Maximum pulling tension shall not exceed 110% final sag tension. The cable pullers, tensioners, and pulling shall be located preferably as near the midspan as possible, but in no case shall the slope of the conductor between the machine and the stringing block at the first structure be steeper than three horizontal to one vertical. Complete manufacturer's data on the tension equipment shall be furnished to the Contractor for approval prior to beginning work. The length of conductor sagged in one operation shall be limited to the length that can be sagged satisfactorily as approved by the cable manufacturer.

Particular care shall be exercised in handling the cables to prevent them from being kinked, twisted, nicked, or abraded in the process of stringing or handling. No bend of less than 12-in. radius will be permitted. All sections damaged by the application of gripping attachments shall be removed or repaired before the conductor is finally sagged in place. The conductor shall be sagged in accordance with the appropriate sag charts supplied by the manufacturer. Conductors shall be pulled to the required initial sag for the temperature at which the sagging operation is carried on. The sag of all conductors after stringing shall be in accordance with the manufacturer's recommendations. All field data such as sag temperature, sag, field computations, and etc. shall be recorded and given to the Contractor.

Sagging operations shall not be performed when wind velocity is in excess of 10 mph or when other physical conditions exist which will prevent satisfactory sagging. The conductor shall be allowed to hang in the stringing blocks more than 18 hours before being pulled to the specified sag. After being sagged, the conductor shall hang in the stringing blocks for not less than 2 hours nor more than 18 hours, before being clamped or tied in.

The type, size, and shape of stringing sheave grooves shall conform to the recommendation of the conductor manufacturer and shall be subject to the approval of the Contractor or designated representative.

The Subcontractor shall furnish from the manufacturer all sag charts for the conductor used.

The contractor reserves the right to perform any desired checking and/or correction of the Subcontractor's line sags; but shall not relieve the Subcontractor of responsibility for the adequate performance of work.

Sag shall match that of the existing line.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: The following inspections, test and reports shall be made prior to contractor acceptance of work conducted under this subcontract:

1. Material and devices shall be inspected prior to and after installation to verify that they are the quality and type required by subcontract specification and drawings, free of damage and that they have been properly installed.

2. Test and verify that each over head distribution line conductor sag meets approved manufacturer sag chart.

3. Visual inspections to determine that all electrical connections are properly made.

4. Electrical continuity tests to determine that all conductors are properly installed, connected, and clear of shorts and grounds.

5. Visual inspection to determine conductor splices are properly made.

6. Provide inspection reports for all inspections performed.

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16414

SECTION 16450--GROUNDING

PART 1--GENERAL

SUMMARY:

Section Includes: Work includes, but is not limited to:

Subcontractor shall provide and install grounding of sizes, ratings, materials and types as shown on the drawings and as recommended by the NEC and the NESC.

Section Does Not Include: For grounding requirements for the following systems, see the Section listed:

Communication Systems:

| | |
|---|---|
| 16610 | Telephone System |
| 16721 | Fire Alarm and Supervisory (FA) System |
| 16725 | Emergency Notification System |
| 16123 | Fiber Optic Cable Installation |

Related Sections:

| | |
|---|---|
| 02444 | Chainlink Fencing |
| 16000 | Electrical Sections |

REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein. Unless otherwise indicated use the latest edition in effect as of the date of these specifications.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 National Electrical Code (NEC)

AMERICAN NATIONAL STANDARDS ASSOCIATION (ANSI)

ANSI C2 National Electrical Safety Code (NESC)

SUBMITTALS:

See the Vendor Data Schedule.

PART 2--PRODUCTS

MATERIALS:

Equipment grounding conductors shall be green insulated or bare copper, sized and located as shown on the drawings.

Grounding rods shall be a minimum of 3/4-in. diameter and 10 ft long copper clad steel.

Exothermic welds shall be Cadweld.

Nonreversible compression fittings shall be Burndy HyGround.

Ground bus bar for installation in manholes shall be 1/4" thick x 4" W x 24" L with mounting insulators and brackets. VFC, Inc., GBI Series.

PART 3--EXECUTION

INSTALLATION:

Install a complete grounding system as indicated on the drawings in accordance with applicable requirements of the NEC, the NESC, and complying with recognized industry practices to ensure that products serve intended functions and comply with requirements.

All exposed noncurrent-carrying metallic parts of electrical equipment, raceway systems (including manholes), building steel and the neutral conductor of the wiring system shall be grounded. The riser of all firewater systems and all in-building, non-firewater, metallic piping shall be grounded.

Beam or compression type grounding clamps shall be used for all above grade grounding attachments to building steel.

All conduit (except spares) shall contain a dedicated grounding conductor.

Conduit shall not be used as the grounding conductor.

Grounding Rods: Grounding rods shall be driven around the building adjacent to the grounding grid and connected thereto. The grounding rods shall be driven so that the top of the rod is 1 ft below finished grade.

Nonreversible Compression Connections: Connections shall be made in accordance with manufacturer's written recommendation.

Exothermic Welds: Exothermic welds shall be made in accordance with the manufacturer's written recommendations.

FIELD QUALITY CONTROL:

Site Tests: The Subcontractor or his agents shall perform visual inspections to determine that the grounding installation conforms to the NEC, these specifications, and the drawings.

Resistance Test: The Subcontractor or his agents shall perform a resistance to ground test on all made electrodes. Any made electrodes having a resistance to ground greater than 25 ohms shall be supplemented with an additional electrode.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16450

# SECTION 16462--TRANSFORMERS, PAD MOUNTED, OIL FILLED, POWER

## PART 1--GENERAL

### SUMMARY:

The Subcontractor shall provide and install the transformer as shown or listed on the drawings.

Section Includes, but is not limited to:

The Subcontractor shall install the transformer in the approximate locations shown, providing the transformer pad, and the compliance with all provisions of the NEC and NESC as to clearances, grounding, location, local disconnects, and NEMA ratings.

Related Sections:

16000 Electrical General Provisions

### REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

Section 16000 References

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

| | |
|---|---|
| ANSI-C57 12.70 | Terminal Markings and Connections for Distribution and Power Transformers |
| ANSI-C57 12.80 | Terminology for Power and Distribution Transformers |
| ANSI-C57 12.98 | Guide for Transformer Impulse Tests |

NATIONAL ELECTRIC MANUFACTURERS ASSOCIATION (NEMA)

| | |
|---|---|
| NEMA TRI-1974 | Transformers, Regulators and Reactors |

SUBMITTALS:

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements:

QUALITY CONTROL:

Regulatory Requirements (Codes and Standards): Comply with provisions of the following codes and standards unless otherwise specified herein.

Section 16000, Electrical General Provisions.

PART 2--PRODUCTS

MATERIALS:

This specification covers the design, fabrication, installation, testing and inspection of oil filled, pad mounted, power transformers.

It is not the intent to set forth those performance requirements, which are adequately specified in applicable standards.

All components shall function in a satisfactory manner within their rated capacity under the specified service conditions regardless of whether all necessary specific performances are set forth herein or in applicable standards.

TECHNICAL REQUIREMENTS:

The transformer shall be compartmental type, self-cooled, tamperproof and weatherproof for mounting on a pad and shall comply with latest applicable standards of the National Electrical Manufacturers Association (NEMA) and the American National Standards Institute (ANSI). There shall be no exposed screws, bolts or other fastening devices, which are externally removable.

The transformer shall be of the sealed tank construction of sufficient strength to withstand a pressure of 7 psi without permanent distortion. The cover shall be welded and the fastenings tamperproof. The transformer shall remain effectively sealed for a top oil temperature range of 50°C to 106°C. When required, cooling panels will be provided on the back and sides of the tank. Lifting eyes and jacking pads will be provided.

The core and coil assembly shall be wound core type with aluminum windings. A tap changing mechanism shall be provided for de-energized operation only and externally operable with two 2.5% full capacity taps above and two 2.5% full capacity taps below normal rated primary voltage.

The high and low voltage compartments shall be located side-by-side and separated by a steel barrier. When facing the transformer, the low voltage compartment shall be on the right. Terminal compartments shall be full height, air filled, with individual doors. The high voltage door fastening shall not be accessible until the low voltage door has been opened.

The low voltage door shall have a 3-point latching mechanism with vault type handle having provisions for a single padlock. The doors shall be equipped with lift-off type stainless steel hinges and doorstops to hold the doors open when working in the compartments. The front sill of the compartment shall be removable to allow the transformer to be rolled or skidded into position over conduit stubs. ANSI tank grounding provisions shall be furnished in each compartment.

The transformers shall be of Wye/Wye construction.

HIGH VOLTAGE TERMINATIONS AND EQUIPMENT:

The high voltage terminations and equipment shall be Dead Front and conform to ANSI C57.12.26 requirements.

Dead Front bushings shall be one piece integrated type for use with elbow terminators and shall be externally clamped.

LOW VOLTAGE TERMINATIONS AND EQUIPMENT:

The low voltage bushings shall be molded epoxy and provided with blade type spade terminals with NEMA standard hole spacing arranged for vertical take-off. The low voltage neutral shall be an insulated bushing grounded to the transformer tank by a removable grounding strap.

ACCESSORIES:

Furnish the following accessories: Nameplate in low voltage compartment, 1 in. upper filter press and filling plug, 1 in. drain plug, liquid level indication (pipe plug at 25°C oil level), 1 in. drain valve with sampling device, dial type thermometer, liquid level gauge, pressure relief device (self resealing with indicator), mounting provision for low voltage current transformers and potential transformers.

Metal-oxide, gapless type lightning arresters shall be installed by the manufacturer on the high voltage side of the transformer to provide additional protection against high voltage lightning or switching surges.

Provide a watt-hour demand meter with a 30-minute demand interval.

The enclosure is to be cleaned, phosphatized, primed and finished with a weather resistant coating.

All current carrying parts shall be copper with both moving and stationary contacts silver-plated.

The transformer shall be of new construction.

SOURCE QUALITY CONTROL:

The Vendor shall maintain a Quality Control Program during the performance of the subcontract which provides adequate quality control throughout design, fabrication, testing, inspection and shipping of the transformer.

Manufacturer's Testing: Tests shall be performed in accordance with ANSI. All testing shall be done at the factory and the certified results shall be submitted to the buyer for approval prior to shipment of transformer.

PACKAGING AND PREPARATION FOR DELIVERY:

The transformer shall be prepared for shipment within the Continental United States. All accessories shall be protected from damage. The transformer shall be sealed to prevent entry of moisture of foreign materials during shipment. Documents as indicated shall be required.

PART 3--EXECUTION

INSTALLATION:

Install transformers as indicated on the drawings and in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation," and complying with recognized industry practices to ensure that products serve intended functions.

FIELD QUALITY CONTROL:

Subcontractor Inspection and Testing: Visual inspection to determine that equipment installation conforms to NEC, these specifications and the drawings.

Contractor Inspection and Testing: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16462

# SECTION 16500--LIGHTING

## PART 1--GENERAL

### SUMMARY:

Section Includes: Work includes, but is not limited to:

The Subcontractor shall provide, install and terminate lighting fixtures of sizes, types, and ratings as shown on the drawings; comprised of, but not necessarily limited to, lamps, lampholders, reflectors, ballasts, starters, wiring and anchor systems.

Provide and install the necessary equipment for supporting or coordinating the hanging of all light fixtures.

Related Sections:

16120 Cable, Wire, Connectors and Miscellaneous Devices

### REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein:

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

| | |
|---|---|
| NEMA C82.1 | Electric Lamp Ballast – Line Frequency Fluorescent Lamp Ballast (ANSI) |
| NEMA C82.4 | Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps (ANSI) |
| NEMA C82.11 | High-Frequency Fluorescent Lamp Ballast (ANSI) |

NATIONAL FIRE PROTECTION ASSOCIATION

| | |
|---|---|
| NFPA 70 | National Electrical Code (NEC) |
| NFPA 101 | Life Safety Code |

UNDERWRITERS LABORATORIES

| | |
|---|---|
| UL 486A | Wire Connectors and Soldering Lugs for Use with Copper Conductors |
| UL 924 | Emergency Lighting and Power Equipment |
| UL 1029 | High-Intensity-Discharge Lamp Ballasts |
| UL 1598 | Luminaries |

SUBMITTALS:

Submittals included, but are not limited to the following:

Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Include in catalog data the features, accessories and finishes for the following:

1. Physical description of fixture, including dimensions and verification of indicated parameters.
2. Emergency lighting unit battery and charger.
3. Fluorescent and high-intensity-discharge ballasts.
4. Lamps.

Wiring Diagrams: Power, signal and control wiring.

Test Reports: Submit completed test reports in accordance with the Field Quality Control Section.

Warranty: See Section 01300 Submittals for additional warranty information.

1. Special Warranty for Emergency Lighting Unit Batteries
2. Special Warranty for Fluorescent Ballasts

Refer to Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

General: Electro-magnetic, discrete electronic and integrated circuit (IC) electronic ballast design and construction shall conform to Certified Ballast Manufacturer (CBM) Standards.

Regulatory Requirements, Codes and Standards: Comply with the previsions of the following codes and standards unless otherwise specified herein.

1. CBM Standards
2. NFPA-70 NEC Articles pertaining to lighting and fixtures

WARRANTY:

Special Warranty for Emergency Lighting Unit Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials and workmanship within specified warranty period.

Warranty Period: 10 years from date of Substantial Completion. Full warranty shall apply for first year and prorated warranty for the remaining years.

Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which manufacturer agrees to repair or replace ballasts that fail in material and workmanship within specified warranty period.

Warranty Period for Electronic Ballasts: 5 years from date of Substantial Completion.

Warranty Period for Electromagnetic Ballasts: 3 years from date of Substantial Completion.

## PART 2--PRODUCTS

### MANUFACTURERS:

Subject to compliance with requirements, provide products of one of the following:

Ballasts: Motorola, OSRAM Sylvania, Advance Mark V and Advance Mark VII (for dimming).

### FIXTURES AND COMPONENTS:

Provide and install all fixtures, lamps and tubes of the types and wattages indicated on the drawings.

Fluorescent Fixtures: Comply with UL 1598. Fluorescent fixtures shall be rapid start, bipin type, with individually fused, high power factor Class P ballasts as indicated on the drawings.

Fluorescent Ballasts: Fluorescent ballasts shall be integrated circuit (IC) electronic.

Integrated Circuit (IC) Electronic Ballast: IC electronic ballast shall have a minimum power factor of .98, UL Class P, rapid start, rated for starting and operating at a minimum of 60°F. Ballast total harmonic distortion shall be less than 10% according to NEMA C82.11. Lamp current crest factor shall not exceed 1.5, with a sound Level "A". Ballast shall have a frequency of operation of 20K Hz or greater and operate without a visible flicker.

Ballast Sound Level:

Sound Level A – 20 to 24 dB

Metal Parts: Free of burrs and sharp corners and edges.

Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

Plastic Diffusers, Covers and Globes: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat and UV radiation. The lens thickness shall be 0.125-inch minimum unless different thickness is scheduled. The lens shall be UV stabilized.

HID Fixtures: Comply with UL 1598.

High-Intensity Discharge Lamp Ballasts: Comply with NEMA C82.4 and UL 1029. Shall include the following features, unless otherwise indicated.

1. Type: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
3. Normal Ambient Operating Temperature: 104 deg F.

Auxiliary, Instant-On, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when HID lamp reaches approximately 60 percent of light output.

Exit Signs: Comply with UL 924. Exit signs shall be translucent green with opaque white letters. Exit signs shall use LEDs for illumination. Letter size shall be in accordance with NFPA 101.

Emergency Lighting Units: Comply with UL 924. Battery shall be sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty. Charger shall be fully automatic, solid-state type with sealed transfer delay.

## PART 3--EXECUTION

### INSTALLATION:

Install lighting fixtures of types indicated, where shown and at indicated heights; in accordance with lighting fixture manufacturer's written instruction and with recognized industry practices; to ensure that fixtures comply with requirements and serve intended purposes.

Provide and install the necessary equipment for supporting or coordinating the hanging of all light fixtures. Fasten fixtures securely to structural support members of building per UBC Seismic Zone 2b requirements. Minimum horizontal seismic forces shall be 15% of fixture weight for normal lighting and 23% of weight of fixture for emergency lighting. Check to ensure that solid pendent fixtures are plumb.

All fixtures shall be wired from outlet boxes with minimum size No. 12 AWG, type THHN wire for through wiring of fluorescent fixtures.

FIELD QUALITY CONTROL:

Subcontractor Supplied Inspection and Testing: The Subcontractor and his agents shall perform the following tests:

> Upon completion of installation of lighting fixtures, apply electrical energy to demonstrate capability and compliance with requirements. Replace bulbs or tubes that are noticeably dim, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and proceed with retesting.

Contractor Inspection: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

ADJUSTING AND CLEANING:

Clean lighting fixtures of dirt and debris upon completion of installation.

Protect installed fixtures from dirt, debris and damage during remainder of construction period.

END OF SECTION 16500

# SECTION 16610--TELEPHONE SYSTEM

## PART 1--GENERAL

### WORK DESCRIPTION:

The Subcontractor shall furnish and install all materials and labor to implement and complete the installation of telephone systems as described on the drawings and these specifications.

WORK INCLUDED: Work includes, but not limited to,

Installation of telephone/data raceways, enclosures, telephone and data cable, outlet modules, and other associated devices as shown on the drawings.

### WORK NOT INCLUDED:

The work not included shall consist of but not be limited to the following:

Final connection to the telephone equipment and devices. This shall be done by others.

### RELATED SECTIONS:

06199 Rough Carpentry
16110 Electrical Raceways
16120 Cable, Wire, Connectors, and Miscellaneous Devices
16123 Fiber Optic Cable Installation
16195 Electrical Identification
16450 Grounding.

### CODES AND STANDARDS:

All components shall comply with NEC Article 800 for telephone systems and service.

All components shall be UL approved.

### SUBMITTALS:

See Vendor Data Schedule for submittals.

PART 2--PRODUCTS

MATERIALS:

Backboards: Backboards covering less than 16 $ft^2$ of total area shall be 3/4 in. AD plywood painted with two coats of fire retardant paint. The paint color shall be off-white. Backboards covering more than 16 $ft^2$ shall be 3/4 in. AD plywood covered with 5/8 in. sheetrock. Sheetrock and plywood edges shall be painted with two coats of fire retardant paint. The paint color shall be off-white.

Ground Bar: Ground bars shall be Newton 1/4 × 4 × 10 in. copper insulated ground bar. Anixter No. 108830.

Voice/Data Outlet Box Face Plates and Modules: See the drawings for the material information.

Cable: The 25 and 50 pair telephone cable shall be Belden filled ASP cable ANMW 24 gauge.

PART 3--EXECUTION

BACKBOARDS:

Backboards shall be installed in the telephone/communication room at locations shown on the drawings.

VOICE/DATA OUTLET BOXES:

Voice/data outlet boxes shall be mounted as indicated on the drawings.

CONDUCTORS:

Fiber optic cable shall be installed in accordance with Section 16123--Fiber Optic Cable Installation.

Cable installed in underground conduits or duct systems shall be labeled at each pull point. The label shall identify the cable size and the buildings they feed and area fed from. Each cable shall be tagged within 1 ft of where it exits the manhole.

Cables installed in manholes shall be racked in a neat and orderly manner.

QUALITY CONTROL TESTING:

Site Testing: The Subcontractor shall inspect cables for physical damage and test each conductor for continuity.

The Subcontractor shall make certain that the use of the installation devices and test equipment is operated as directed by the equipment manufacturer. Verification of training on the instrumentation to be used in the installation, termination, and testing of the voice/data cable is required to be submitted to the Subcontractor. All Subcontractor personnel terminating and testing voice/data cable will be required to provide evidence of a current BICSI Technician level certification.

The Contractor's Representative shall witness the tests and the test report shall be signed and dated by the Subcontractor and the Contractor's Representative.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16610

# SECTION 16650--INSTRUMENTATION GENERAL PROVISIONS

## PART 1—GENERAL

### WORK DESCRIPTION:

The subcontractor shall furnish all supervision, labor, material, equipment, and supplies (except Government-furnished materials and/or equipment) and perform all work in accordance with the subcontract drawings and these specifications. Unless otherwise specified, references in these specifications or on the subcontract drawings to other specifications, codes standards or manuals, which are a part of these specifications, but not included herein shall be the latest edition of these publications, including any amendments and revisions in effect as of the date of this Specification. In general all work shall be in compliance with applicable sections of 29 CFR 1910 General Industry Safety Standards, 29 CFR 1926 Construction Industry Safety Standards.

This section applies primarily to those drawing with a Sheet Number type IN. For example IN-1, IN-2, etc. Other related information is conveyed in the E drawings.

### WORK INCLUDED:

Work in and around building CPP-1688 includes, but is not limited to:

- Installing a programmable logic controller, monitor, new controls, relays and wiring.
- Installing terminal blocks and relays in a new terminal box.
- Installing pressure transmitters and flowswitches outside near filter banks.
- Installing an alarm light on the outside of the building.
- Installing conduit and conductors related to the above items.

### QUALITY CONTROL:

Codes and Standards: National Electrical Code (NFPA 70): Work and materials shall conform to the related sections of the National Electrical Code

Underwriters' Laboratories (UL): All materials, appliances, equipment or devices shall conform to the applicable standards of Underwriters' Laboratories, Inc. All material, appliances, equipment or devices as far as possible shall be listed and/or labeled by UL.

Field Quality Control: Quality Assurance Program requirements shall exist to assure that all work performed is in conformance with the requirements established by the drawings and this specification. The Contractor's Representative shall witness all testing as noted throughout these specifications.

SUBMITTALS:

Shop Drawings and Vendor Data: Copies of shop drawings and/or vendor data for materials and equipment to be furnished by the Subcontractor shall be submitted by the Subcontractor for the Contractor's review if different from items specified on the drawings. The Subcontractor shall also turn over any documentation packaged with government furnished items. The data submitted shall be in such detail as to clearly illustrate the materials and equipment, including components and the fabrication thereof, that the Subcontractor proposes to furnish. If the submitted items change electrical termination points as shown on the design drawings the Subcontractor shall also submit red line drawings. These red drawings shall show the changes and shall be approved before the item is installed. For example suppose a relay is submitted for approval with coil termination points 2 and 7 and on the design drawings the coil termination points are shown as N and K. For this case in addition to the above requirements the Subcontractor will also submit a red line mark up of the affected design drawing showing the terminals changing from N and K to 2 and 7. The drawings and changes shall be made at no cost to the Contractor.

Hazardous Chemicals and Substances: Material Safety Data Sheets as required by 29 CFR 1926.59, Hazard Communication Standard, shall be submitted for approval before use of the hazardous substance.

PART 2--PRODUCTS

GENERAL:

Furnish all labor, materials (except government furnished material), equipment and appliances required to complete the installation of the complete instrumentation systems. All labor, materials, service, equipment, and workmanship shall conform to the applicable chapters of the National Electrical Code NFPA 70, Occupational Safety and Health Administration (OSHA). All modifications required by these codes, rules, regulations, and authorities shall be made by the Subcontractor without additional charge to the Contractor.

All materials, equipment and installations shall be accessible for inspection by the Contractor or his designated representative during any phase of construction, fabrication, manufacture and erection or testing.

Tubing Materials:

Tube fittings if specified on the drawings may not be substituted. Swagelok by Crawford Fitting Company and Cajon Company are the only acceptable type tube fittings. All in line tubing valves shall be Swagelok SS-6P4T or SS-43S6. All tubing shall be high quality Seamless, grade TP304 or TP316 stainless steel conforming to ASTM A269 and free of scratches. All tubing shall be of the size shown on the drawings.

GOVERNMENT FURNISHED MATERIAL (GFE):

All material other than the PLC assembly labeled PLC-YDJ-63 and operator interface labeled OWS-YDJ-963 shall be provided by the Subcontractor. The government furnished material shall be obtained prior to the start of any installation work and stored in the area designated by the contractor along with new material provided by the Subcontractor. At completion of the job, any unused government furnished material shall be returned to the Contractor.

CONDITION OF PRODUCTS:

Provide new products, free of defects and harmful deterioration at the time of installation. Provide each product complete with trim, accessories, finish, guards, safety devices and similar components specified or recognized as integral parts of the product, or required by governing regulations.

Unless otherwise indicated by the drawings or specifications or approved in writing, the materials and/or equipment furnished under these specifications shall be the standard products of manufacturers regularly engaged in the production of such equipment, and shall be the manufacturer's standard design.

Damaged Materials: All materials and equipment received by the Subcontractor in a damaged condition, shall be repaired or replaced by the Subcontractor as directed by the Contractor. Materials and equipment damaged by the Subcontractor shall be repaired or replaced by the Subcontractor at Subcontractor expense.

Uniformity: Where two or more units of the same type and class of material or equipment are required, the units shall be the product of the same manufacturer, and shall be identical insofar as possible. The component parts of a unit of equipment need not be the products of the same manufacturer.

PART 3--EXECUTION

Repair of Damages: Construction materials and equipment, threads, machined or painted, and other exposed finished surfaces shall be protected from damage at all times during shipping, handling, construction and installation. Materials and equipment repaired or replaced by the Subcontractor shall be subject to acceptance by the Contractor or the Contractor's Representative.

Existing Materials, Equipment and Structures: Existing materials, equipment and structures, including paint and protective coatings, involved under this Subcontract shall be thoroughly inspected by the Subcontractor before starting any work. Any defects or damages, the repair of which are not covered under these specifications or subcontract drawings, shall be reported in writing to the Contractor by the Subcontractor. The

Subcontractor shall place reinstalled operating equipment in an operating condition that is at least as good as it was at the time the Subcontractor started work.

Tubing Installation: Tubing shall be square cut using tube cutters and all ends shall be reamed to full tube inside diameter. Burrs shall be removed from each cut and the tubing shall be cleaned of foreign matter before installation. All tubing bends shall be made with a tube bender. Follow manufacturer's recommendations for bend radius. No tubing run shall be laid one on top of another. Wherever possible, the tube runs shall be laid out avoiding crossing one tube over another. Where this is unavoidable, clearance shall be provided to prevent chafing and to allow for maintenance. Tubing runs requiring the use of unions shall have the tubing bent to lift the union from the surface for ease of inspection and maintenance. The minimum bend radius shall be 5 times the nominal tubing outside diameter.

Tubing Fittings Installation: The Subcontractor is responsible for providing all tube fittings required. Tube fittings if specified on the drawings may be substituted as to form in function groups, i.e., a male connector for a male elbow. Couplings are not shown on the drawings and shall be supplied by the Subcontractor as required. Tube fittings as to manufacturer may not be substituted. Swagelok fittings shall be installed using manufacturer's recommended installation instructions. The Subcontractor shall have onsite at least one copy of "Swagelok Tube Fitting and Installation Manual" and shall ensure that personnel installing tubing and fittings are familiar with its contents. Conformance to the "1-1/4 Turn" tightening procedure is of particular importance. The Subcontractor shall ensure that all personnel installing tubing are furnished with Swagelok "No Go" inspection gauges and that every fitting is checked with a gauge by the installer upon completion of the "1-1/4 Turn" tightening procedure. All 035 wall tubing shall be tightened using the side of the "No Go" gauge marked 1-1/4 from finger tight.

Tubing Support: Tubing support shall be with tube clamps, Unistrut P2010 in conjunction with steel channel. Unistrut type P2010 one hole clamps alone may be used for locations that channel is not feasible. Supports shall be placed at intervals not to exceed 15 feet on vertical runs and 10 feet on horizontal runs. The installation shall support the tubing without sagging and shall be clear of the work of other trades.

COORDINATION OF INSTRUMENTATION WORK:

General Requirements: Materials and equipment shall be erected or installed only by qualified personnel who are regularly engaged in the trades required to complete the work. The subcontract drawings show the general arrangement and space allocation of the equipment specified. It shall be the Subcontractor's responsibility to verify changes in conditions or rearrangements necessary because of substitutions for specified materials or equipment. Where rearrangements are necessary the Subcontractor shall, before construction or installation, prepare and submit drawings of the proposed rearrangement for approval. The drawings and changes shall be made at no cost to the Contractor.

Coordination of Work: Where new work and existing facilities are shown on the drawings, the Subcontractor shall be responsible for proper location and clearances and for correcting discrepancies and interferences in the work which are a result of his operations. Work done by one trade that must be integrated with work of other trades shall be laid out with due regard to the work done, or to be done, by interfacing trades. The Subcontractor shall cooperate in coordinating his work with work being done by others. The Subcontractor shall notify the Contractor at least one week prior to the date on which the Subcontractor proposes to proceed with the work.

Painting: Paint those areas exposed outside with an alkyd primer conforming to Federal Specification TT-C-530 and a Semi-Gloss Alkyd Enamel finish conforming to Federal Specification TT-E-529. Apply one coat of primer and two coats of finish paint. Paint shall be applied in such manner as to preclude runs, sagging, brush marks, holidays or other defects in the finished surface. All paint shall, otherwise, be applied in strict accordance with the paint manufacturer's directions.

As to an alternative to painting on outdoor structure elements, stainless steel may be substituted for carbon steel.

Workmanship: All work shall be done in a skillful and workmanlike manner. The Subcontractor shall do all structural cutting, fitting, patching, repairing and associated work necessary for installation of equipment, wiring and electrical conduits, etc. No major cuts or holes, not shown on the drawings, shall be made without prior approval of the project manager. After the equipment and/or conduit is installed, all exposed holes, cracks and other defects shall be neatly patched and the patched areas shall match the adjoining materials and finish.

Arrange work in a neat, well organized manner with conduit and similar services running parallel with the primary lines of the building construction, and with a minimum of 7 ft-0 in. overhead clearance where possible.

Locate operating and control equipment properly to provide easy access, and arrange entire instrumentation work with adequate access for operation and maintenance.

Advise other trades of openings or clearances required in their work for the subsequent move-in and assembly of large units of equipment.

Electrical connections shall be tightened to torque specifications stated by the equipment manufacturer.

Ensure instruments and electrical equipment are mounted per manufacturer's recommendations using the provided mounting holes, brackets and hardware.

Dimension Verification: The subcontractor shall field verify dimensions prior to fabrication.

LABELING:

Equipment: Install the engraved labels as shown on the drawings. Identifying items with marking pens, adhesive tape, embossed plastic or metal tape, or similar type means is not acceptable.

Labels shall be laminated phenolic or plastic colored black with white engraved letters.

Unless shown otherwise on the drawings equipment mounted outside shall be labeled with a stainless steel tag of a thickness not less than 20 gauge with legend letters not less than ¼ inch tall.

If not shown on the drawings equipment nametags shall be installed by one of the following means:

a. Hung off equipment with 1/16-inch stainless steel bead chain or cable.
b. If inside, attached to equipment or immediately next to equipment using a suitable adhesive such as General Electric RTV silicone rubber. They may also be attached to equipment or immediately next to equipment using bolts, screws or rivets.
c. If outside, attached to equipment or immediately next to equipment using bolts, screws, or rivets.

Wire: All conductors or cables shall be identified with white heat shrink tubing with black typed on minimum 3/32 inch letters with non-smear ink such as Brady-321, Brady-322 or approved equal. Hand lettered labels shall not be used. All conductors or cables shall be labeled with point-to-point destination. Wire label legends shall follow an origin/destination practice. For example consider a single conductor between terminal 8 on TB9 in CP-YDJ-963 and terminal A on instrument FSL-YDJ-3. At CP-YDJ-963 the label would be 8/ FSL-YDJ-3-A and at FSL-YDJ-3 the label would be A/CP-YDJ-963-TB9-8. If legend length would exceed label length it is acceptable to drop the subarea (YDJ) from the legend.

Red Line Requirements: The Subcontractor shall maintain a set of red line drawings for the entire project that must be updated on a daily basis. The update must include wiring changes and major (greater than 2 feet in location or 6 inches in size) changes in equipment locations, sizes, and elevations. The red line drawings shall also show all changes to List of Material information.

The above update will be subject to monitoring on a daily basis by the Contractor's Representative. The Subcontractor may use the existing project drawings to perform the update. Upon completion of the project the Subcontractor must submit the as-built red line drawings as vendor data for approval.

QUALITY CONTROL TESTING:

Subcontractor Supplied Testing:

Electrical Continuity: After conductor connectors are installed and conductors are labeled, but prior to termination to terminals or devices, an electrical continuity test shall be performed on each conductor using a battery powered buzzer or ohmmeter to determine that all power, control, grounding and other conductors are properly installed and identified. The Subcontractor shall provide the Test Data Submittal Sheets. List all conductors tested on required test data submittal sheets.

Electrical Meggering: Prior to terminating, test cable or wire of 25 ft or longer for insulation resistance with megger (500 V megger for 300 V insulation and 1000 V megger for 600 V insulation). Any wire with less than 10 megohms to ground or other conductors shall be replaced before proceeding with the terminating. The Subcontractor shall provide the Test Data Submittal Sheets. List conductors tested on required test data submittal sheet.

Tubing Leak Testing: Use a test port on 5-valve manifold as pressure application point for test. Perform test with equalization valve and two isolation valves on manifold open to equalize pressure across pressure diaphragm and pressurize both sensor legs. Pressurize the tubing to a pressure between 4 and 6 psig (higher pressures may damage transmitter). "Snoop test" all connections from transmitter to isolation valve at filter. "Snoop test" refers to the coating of all new fittings or joints with a liquid that provides bubbling action if exposed to a gas system leak such as Nupro Company SNOOP liquid leak detector. The joints or fitting shall be observed for a period of 30 seconds minimum for the formation of bubbles or any other indications of leakage around the entire circumference of the joints. Any sign of leaking will be stopped by the Subcontractor and the fitting retested. Any repair of leakage beyond tightening fittings must be approved by the Contractor.

Contractor Testing: Upon completing installation of all systems and equipment, but prior to project close out, the contractor will conduct an operational test of all equipment, controls and devices installed or modified by the Subcontractor. All equipment (except GFE) shall test satisfactory or be repaired or replaced at no additional cost to the contractor.

FIELD QUALITY CONTROL:

Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications.

END OF SECTION 16650

# SECTION 16721--FIRE ALARM (FA) SYSTEM

## PART 1--GENERAL

### SUMMARY:

Section Includes: Work includes, but is not limited to:

Provide a complete fire alarm system as described herein. Provide design, installation and testing of the systems. The systems consist of a Fire Alarm Control Panel designed to be a conventional fire alarm control panel with Class A, Style D, initiation device circuits, Class B, Style W, notification appliance circuits, having a 24-hour backup power supply plus 5 minutes in alarm. The system will monitor fire sprinkler waterflow, manual fire alarm stations, duct smoke detectors, and sprinkler system control valve tamper switches. The fire alarm control panel will be equipped with a DACT using BFSK protocol to transmit Alarm, Supervisory, and trouble signals over standard telephone circuits to the Fire alarm monitoring system.

### REFERENCES:

The following documents, including others referenced therein, form part of this Section to the extent designated herein.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

| | |
|---|---|
| NFPA 70 | National Electrical Code |
| NFPA 72 | National Fire Alarm Code |
| NFPA 90A | Installation of Air Conditioning and Ventilation Systems |
| NFPA 101 | Life Safety Code |
| NFPA 170 | Fire Safety Symbols |

UNDERWRITERS LABORATORIES (UL)

Fire Protection Equipment Directory
Electrical Construction Materials Directory
Building Materials Directory

FACTORY MUTUAL ENGINEERING CORPORATION (FM)

FM Approval Guide

DEPARTMENT OF ENERGY

DOE-ID Architectural Engineering Standards Appendix L

SUBMITTALS:

Submittals include, but are not limited to the following:

- Equipment label list
- Wire label list
- Record of completion as required by NFPA 72
- Owners manual
- Wire and cable tests including opens, shorts, and impedance
- Battery backup design calculations
- A copy of the proposed system acceptance test after approved design and prior to construction
- The completed Inspection and Testing form as required by NFPA 72
- One copy of the completed "As-built" drawings for the fire alarm system including program software
- A copy of the designer's certification
- A copy of the installer's certification and experience

Design: The fire alarm system design shall be submitted as a complete package for review. Partial submittals will be considered as incomplete and will not be reviewed. The design must be approved by the Contractor prior to beginning of installation and shall comply with NFPA 72 requirements.

Proof of certification per Qualification requirements shall be provided with the design package.

Design drawings shall comply with the requirements of Section 01300 Submittals. A National Institute Certified Engineering Technician NICET, level III, shall sign all drawings.

Equipment: Catalog data and other information necessary to show compliance with this specification shall be submitted for approval for the following equipment:

- Transient eliminator (Surge suppresser)

Procedures: The Subcontractor shall submit an acceptance test procedure that will be used to verify proper operation of all new fire alarm equipment.

Test Reports: Completed acceptance test document shall be submitted to the Contractor's Representative (LSS) after the test. System certification, System Operations test, and System Test documentation shall be provided as a package.

See Section 01300, Submittals and the Vendor Data Schedule for additional submittal requirements.

QUALITY CONTROL:

Qualifications: The Subcontractor for the fire suppression system shall have a National Institute Certified Engineering Technician, (NICET), Level III rating in Fire Alarms responsible for overseeing the preparation of the layout drawings and installation. The Technician shall be Factory certified on the equipment installed.

This person shall be required to certify that the drawings are in accordance with this specification and all referenced regulatory requirements and that the system is installed in accordance with the drawings and specifications.

Experience: The Subcontractor shall have a minimum of three- (3) year's experience in the installation of the Fire Alarm System(s).

Codes and Standards: All equipment provided and the installation of the fire alarm and supervisory system shall comply with the applicable sections of the following codes and standards:

NFPA 70
NFPA 72
NFPA 90A
NFPA 170

MAINTENANCE:

Training:

Factory training shall be provided at the INEEL for maintenance and operation for the LSS personnel. This training shall include factory certification for the LSS personnel to perform corrective and preventive maintenance.

PART 2--PRODUCTS

MATERIALS:

All materials, appliances, equipment or devices shall be new, UL listed and/or FM approved for use in the intended application. All individual components and composite systems shall be designed for continuous operation without undue heating or change in rated values.

Circuit Breakers: Circuit breakers protecting fire alarm equipment shall be marked with red engraved phenolic resin tags with white lettering stating FIRE PROTECTION EQUIPMENT. A protective device shall be installed on these breakers to prevent inadvertent operation.

Batteries: All batteries shall be sealed, lead acid batteries.

Devices: Provide all devices required for a working system. Provide all new equipment including but not limited to terminal boxes, transient eliminators, terminal strips, terminal lugs, conduit and wire.

Conduit: All wiring shall be in conduit. Conduit for the fire alarm system shall be dedicated for fire alarm circuits. Initiation and notification circuits shall not share the same conduit. See Section 16110 of this specification for conduit requirements.

Cable and Wire: Wire/cable shall not be spliced except on a terminal strip and shall be continuous up to termination points. New fire alarm cable shall be twisted pair, minimum 18 AWG, 600 volt. Fire alarm cable shall be power limited as described in NEC 760-51 (a) through

Wire Labels: Brady type B-322, Self-Extinguishing Heat-Shrink Polyolefin.

Spade Terminal Lugs: Spade lugs shall be used on all terminals when compatible. AMP stud sizes 6, for wires size 16 AWG.

Terminal Strip: Terminal strips shall be compatible with spade terminal lugs. Any wiring not using lugs shall be tinned with solder prior to connecting to equipment. Terminal strips shall be rated 300 volts minimum, 15 Amps minimum. All terminal strips shall have barriers between terminals.

NOTE: Connecting un-lugged wires to terminals designed for lugs is prohibited.

Pressure Type Terminal Connections: Any wiring terminated to pressure type terminal connectors shall be tinned with solder prior to connection to equipment.

Transient Eliminators: A JA (Junction Arrestor) box shall be installed on all metallic wire circuits entering a building and connected to a control panel. Transient eliminators shall be used to protect existing panels from lightning. Transient eliminators, shall be provided for, and be compatible with, fire alarm circuits, and. The JA boxes shall be expandable up to 6 circuits. If transient eliminators are not provided with manufactures enclosure they shall be installed in a NEMA 1 enclosure with hinged cover that can latch closed and back plate Hoffman # A-12N12A minimum size. Transient eliminators shall be compatible for initiating and indicating appliances under 30 volts dc. Transient eliminators shall be wired and bonded to building grounding system. Furnish and install minimum 6 AWG ground wire from transient eliminators to building ground system.

Manual Fire Alarm Pull Boxes: Manual fire alarm pull boxes shall be double action type with single pole double throw contacts mounted on a back box. "Break Glass" types are not acceptable. The manual fire alarm stations shall be UL listed.

Duct Smoke Detector. The duct smoke detectors shall be System Sensor Model DH100P equipped with RTS451KEY remote test station and ST-3 metal sampling tube. The detector shall be UL 268A listed.

Fire Sprinkler Waterflow Switch shall be supplied as shown on the fire sprinkler system drawings and connected by the fire alarm Subcontractor.

Fire Sprinkler System Valve Supervisory Switch shall be as specified on the fire sprinkler system drawings and connected by the fire alarm Subcontractor.

Audible/Visual Occupant Notification Device shall be a System Sensor Model PC 24 (Cd rating) for ceiling mounted units and System Sensor Model P24 (Cd rating) for wall mounted units. Audible devices shall be UL 464 listed and visual devices shall be UL 1971 listed.

Digital Alarm Communications Transmitter (DACT): The DACT shall be a Firelite Model 911 which will communicate over standard dial tone circuits with an Ademco Model 685 DACR using Radionics BFSK communications protocol located in the Fire Alarm Center in CFA 666. The DACT shall be UL listed.

## PART 3--EXECUTION

### INSTALLATION:

Audibles shall be mounted in accordance with NPFA 72 Chapter 4. Strobe shall be mounted below speaker. Mounting in false ceiling is permitted. Audible and strobes shall be mounted in UL listed enclosures.

Cable shields shall be terminated to the surge suppresser terminal point marked for terminating the shield. Cable shields not terminated shall be cut back to cable jacket and shall be insulated using heat shrink tubing (the only shield not connected will be the most remote location from the single ground connection). Cable shields shall not be connected in manner that creates a ground loop.

Fire alarm control panel and terminal boxes shall be mounted 6 feet above finished floor to top of enclosure unless specified otherwise.

Manual fire alarm pull boxes shall be mounted at 42 inches above finished floor unless specified otherwise.

INSTALLING CONDUITS OR ANY OTHER PENETRATION IS PROHIBITED IN THE TOP OF ANY FIRE ALARM CONTROL PANEL, TERMINAL BOX, OR SURGE SUPPRESSER BOX.

Notification: The fire alarm Subcontractor shall notify the Contractor in writing two weeks prior to beginning work. The Subcontractor shall not connect into or modify any part of the existing fire alarm system unless authorized by the Operating Contractor's Representative.

Final Connection to Existing Systems: The Subcontractor shall have the Contractor's Representative present during all tie-ins to the existing plant fire alarm and emergency notification systems.

WORKMANSHIP:

All work shall be done in a skillful and workmanlike manner. The Subcontractor shall do all construction work associated with the installation of equipment. No modifications or rearrangements, not shown on the drawings, shall be made without prior approval from the Contractor. After the equipment is installed, all wiring in enclosures shall be neatly secured in place by cable ties. Conductors in cabinets shall be carefully formed and harnessed.

Terminal lugs shall be crimped to conductors with a calibrated crimping tool. The crimping tool shall be compatible with lugs being crimped.

Wiring Styles: Initiating appliances and indicating appliances shall be wired so they are supervised by a direct current supervised system (see NFPA 72 Chapter 3. Fire alarms shall be wired class A, style "D" four wire (see NFPA 72 Table 3-5). Supervisory signal circuits shall be wired class B, style "B" two wire (see NFPA 72 Table 3-5). Wiring for supervisory and fire alarm circuits shall be to the normally opened contact (non-alarm condition) of the device or relay contact. Wire connections shall be made up to the alarm device.

WIRE LABELING:

Pair conductors shall be labeled at each termination point for all circuits with heat shrink labels giving destination location. All wire labels shall be pre-typed; heat shrink labels and shall be heated for uniform shrinkage. Wire labels shall be installed such that the typed information is readily identifiable. To identify each type of device, an abbreviated ID has been assigned for wire label purposes (see E drawings for wire termination connections and abbreviation). The abbreviations shall be used for wire labels. The following list does not intend to be all-inclusive but shall be used as a standard for abbreviated labels.

| | |
|---|---|
| IT-1646-01-01-03 - | Junction terminal box - building 1646 - terminal box 1 - terminal strip 1 - terminal point 3. |
| 124XXXX - | Event number corresponding to hardware address within multiplex panel 24. |
| MFA - | Manual Fire Alarm |

| | |
|---|---|
| SD - | Smoke Detector |
| JA-1606-01-AB-01-01- | Junction arrestor terminal box 1, building 1606, row A, column B, terminal strip 1, terminal point 1. |
| CP-BA-01-02 - | Fire alarm control panel, row B, column A, terminal strip 1, terminal point 2. |

Spare cables shall be labeled. Spare cables shall be labeled giving building to building, enclosure to enclosure, or circuit type. Examples: SPARE 617/660, JA1604-01, PIV-1001.

Labeling Cable or Cable Bundles between Enclosures: Cables or cable bundles from one enclosure to another enclosure shall be labeled.

Labeling shall include an abbreviated destination address identifying the terminal box or fire alarm panel and building number. The label shall also include the words "POWER LIMITED FIRE ALARM". Cables sharing the same raceway with the same destination may use a single cable label if cables are dressed and harnessed separate from other cables in the same enclosure.

The following is a list of abbreviations for enclosures and shall be used as standard when applicable.

| | |
|---|---|
| MIP | Multiplex Interface Panel |
| MP | Miniplex Panel (50 or 100) |
| JA | Surge Suppresser Terminal Box |
| JT | Junction Terminal Box |
| LP | Lighting Panel |
| FOSB | Fiber Optic Splice Box |
| TB | Terminal Box |
| MFA JT | Manual Fire Alarm Junction Terminal Box |
| WF JT | Waterflow Junction Terminal Box |
| DSD JT | Duct Smoke Detector Junction Terminal Box |
| FACP | Fire Alarm Control Panel |
| ONC JT | Occupant Notification Circuit Junction Terminal Box |

EQUIPMENT LABELING:

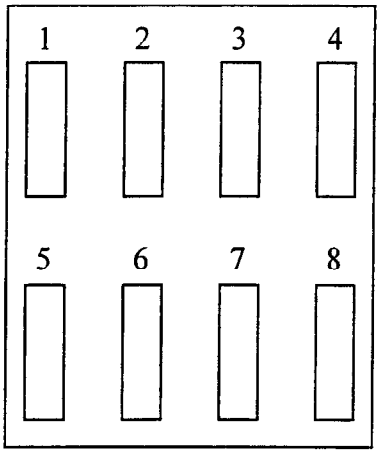
All terminal box numbers, panel numbers, and alarm device event numbers shall be labeled.

Labels shall be made upon red engraved laminated phenolic resin nameplates with white lettering. Lettering for event numbers shall be one half inch high. Lettering for terminal boxes and panels shall be 1 in. high. Labels for equipment shall be permanently installed by gluing, chaining, or screwing them to the equipment.

Labeling Modules within an Enclosure: Modules shall be laid out in rows and columns for identification purposes. Modules shall be identified using a permanent marker identifying their row and column location within an enclosure. The following is an example of how rows and columns should be laid out using a 6-row 4-column array.

| | | | |
|---|---|---|---|
| AA | AB | AC | AD |
| BA | BB | BC | BD |
| CA | CB | CC | CD |
| DA | DB | DC | DD |
| EA | EB | EC | ED |
| FA | FB | FC | FD |

The following is a standard of how terminal strips would be laid out with two rows and four columns.




Label List: The Subcontractor shall provide a list of labels associated with each fire alarm panel for approval prior to installation. The list shall include labels for fire alarm panels, terminal boxes, and alarm devices. The label lists shall be submitted for review and approval prior to installation specifying where they will be used.

FIELD QUALITY CONTROL:

Subcontractor Supplied Testing: Upon completion of the fire suppression system installation, the individual with the NICET level III certification responsible for the system layout, shall conduct the final inspection of the installation test to verify the installation has been installed in accordance with the working drawings and meets the design requirements of this specification.

Acceptance Test Procedure: The acceptance test procedure shall comply with NFPA 72 Figure 7-5.2.2 Inspection and Testing Form. The Subcontractor shall conduct the acceptance using an approved acceptance test procedure document.

All Subcontractor supplied equipment shall test satisfactory or be repaired or replaced at no additional cost to the Contractor.

Test Report: Provide a test report for each terminal box enclosure. The test report shall measure resistance and stray voltages on all alarm wiring. See Installation Testing in NFPA 72 Chapter 7.

Resistance Measurements: Resistance measurements shall be made with an analog meter with input impedance of 20K ohm per volt or greater. A digital meter SHALL NOT be used to make resistance measurements. Measurements shall be read with the meter on the most appropriate scale so that needle deflection is as close to mid scale as possible.

Meggering Testing: Prior to terminating, tests cable or wire of 25 ft or longer for insulation resistance with a megger (500 V megger for 300 V insulation). Any conductor with less than 10 megohms to ground shall be replaced before proceeding with the terminating. List the conductors tested on a test data submittal sheet. Note: No meggering test shall be performed with wiring connected to transient eliminators, modules or panels.

Acceptance: The acceptance test shall include as a minimum, the manufacturers start up procedures, acceptance procedures, and requirements listed in NFPA 72 Chapter 7.

The acceptance test will verify that all equipment has been installed properly and is operable before connecting it to the existing fire alarm monitoring system. Adjustments and settings to achieve correct operation will be made as necessary during the acceptance test. Completed acceptance test document shall be submitted to the Contractor's Representative after the test.

Contractor Supplied Surveillance: Surveillance will be performed by the Contractor's Representative to verify compliance of the work to the drawings and specifications. The Contractor's Representative shall be present during system testing and at the time that final connections to existing systems are made

END OF SECTION 16721